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MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Volume XXIX

July-September 1987

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ON THE GENUS *PITHYELLA*
AND ITS LATER SYNONYM, *HELOTIOPSIS*
(LEOTIACEAE)

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SUMMARY

Pithyella Boud. is shown to be an older name for *Helotiopsis* Höhn., and is accepted for five species, all occurring on cryptogams, two on living mosses, one on fern roots, and two on pyrenomycetes. Six species previously referred to *Pithyella* are excluded. Three species are referred to *Unguiculariopsis* Rehm, one is a later synonym of *Lachnellula theiodea* (Cooke & Ell.) Sacc., one is an apparently 'lost' species, and one is a grossly misdescribed species that belongs in *Claussenomyces*. New combinations proposed are *Pithyella anonyma* (Rehm) Korf & Zhuang, *P. apicalis* (Berk. & Br.) Korf & Zhuang, *P. jenkinsii* (Sherw. & Korf) Korf & Zhuang, and *C. hydnicola* (Berk. & Br.) Korf & Zhuang.

Pithyella Boudier (1885) was erected for a moss-inhabiting species with spherical ascospores and inoperculate asci, earlier described by Quélet (1879) as *Mollisia hypnina*. Quélet's brief description mentioned, and later illustration (Quélet, 1881) showed, marked ascospores (FIG. 1A), but Boudier (1885) indicated that the spores of *Pithyella* were smooth. He later so illustrated them (Boudier, 1905) from a specimen sent to him by Quélet (FIG. 1B). No such smooth-spored species is known on mosses, and apparently Boudier failed to observe the characteristic markings on the ascospores.

Boudier later (1907) greatly enlarged the concept of *Pithyella* by adding six additional spherical-spored species, five of which we exclude from the genus on the basis of our studies. One additional species has since been described in *Pithyella* (Chenantaïs, 1918), which we also exclude.

Three of the eight species that had been placed in *Pithyella* have characteristic, hooked hairs on the excipulum, and occur as hyperparasites on other fungi. The name *Pithyella* has been adopted

in a restricted sense to include only the hooked-haired species by two major workers, Dennis (1960, 1968, 1978) and Moser (1963). Other workers, including Masee (1895), Saccardo and Saccardo (1906), and Seaver (1951), placed these in *Mollisiella* (Phill.) Rehm (1892), a generic name which cannot be adopted for these species since it is a later homonym of *Mollisiella* Boudier (1885).

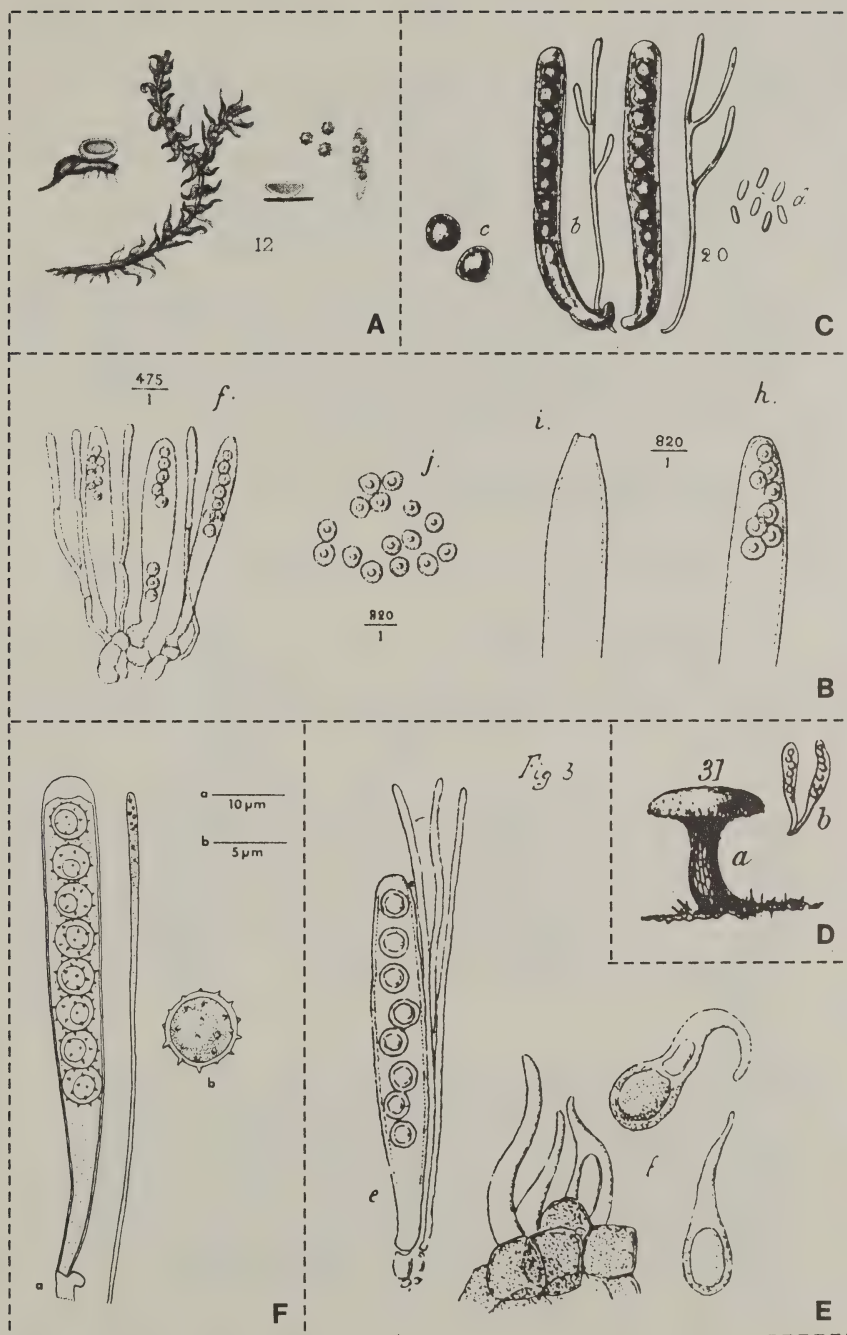
The junior author is undertaking as her doctorate thesis a monograph of the hooked-haired species, which are certainly unrelated to the type species of *Pithyella*, but should be ranged instead in the genus *Unguiculariopsis* Rehm (1909). Korf (1973), following the treatments of Dennis and Moser, thus erred, in our view, in stating that *Pithyella* is a synonym of *Unguiculariopsis*.

Marked ascospores are rare in the Leotiaceae, but do occur in *Helotiopsis* Höhnelt (1910), a genus erected for a species occurring on mosses and another on stromata of a fungus. *Helotiopsis* is clearly a synonym of *Pithyella*, and the three species previously placed in the former (Sherwood & Korf, 1976) are transferred to the genus here.

PITHYELLA Boudier, Bull. Soc. Mycol. France 1: 118. 1885.
(Holotype species: *Mollisia hypnina* Quél.)
= *Helotiopsis* Höhnelt, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 119: 623. 1910. (Holotype species: *Peziza apicalis* Berk. & Br.)

Substrates: on living mosses, fern roots, and fungi.

FIG. 1 A-F. Illustrations at published size (except F) by other authors of species that have been referred to *Pithyella*: A. Illustration by Quélet (1881: pl. 9, f. 12) showing apothecium of *P. hypnina* on moss leaf, moss plant with apothecia in axils of leaves, apothecium in section, three marked ascospores, an ascus. B. Illustration by Boudier (1905: pl. 519, partial) of *P. hypnina* showing in f: asci, ascospores and paraphyses $\times 475$, in h: ascus and ascospores $\times 820$, in i: discharged ascus $\times 820$, and in j: ascospores $\times 820$ (drawn incorrectly as smooth — see text). C. Illustration by Berkeley and Broome (1871: pl. 20, f. 20, partial) of '*Pithyella*' *hydnicola* showing in b: asci containing 'ascospores' (balls of ascoconidia — see text), in c: two 'ascospores,' in d, conidia (ascoconidia? — see text). D. Illustration by Berkeley and Broome (1866: pl. 4, f. 31) of *P. erythro stigma* showing in a: apothecium, and in b: asci and ascospores. E. Illustration by Chenantais (1918: pl. 3, f. 3, partial) of '*Pithyella*' *hamata* showing in e: ascus, ascospores and paraphyses, and in f: hooked excipular hairs and excipular cells. F. Illustration by Sherwood and Korf (1976: fig. 1, partial, reduced) of *P. jenkinsii* showing in a: ascus and ascospores, and paraphysis, and in b: ascospore.



Accepted species:

1. *Pithyella anonyma* (Rehm) Korf & Zhuang, *comb. nov.*
 = *Pezizella anonyma* Rehm, *Hedwigia* **34**: 165. 1895.
 = *Mollisiella anonyma* (Rehm) Rehm, *Hedwigia* **44**: 9. 1905.
 = *Helotiopsis anonyma* (Rehm) Höhn., *Oesterr. Bot. Z.* **1913**: 301. 1913 ('*anonymous*'); combination by Sherwood & Korf in *Mycotaxon* **3**: 323. 1976, was superfluous.

NOTES: A description and illustration of this species on the stromata of *Valsaria crenata* Rehm in Ecuador is provided in Sherwood and Korf (1976). There is some doubt whether the ascospores are marked or not. The type collection was issued as an exsiccati specimen (Rehm, *Ascomyceten* 1115b).

2. *Pithyella apicalis* (Berk. & Br.) Korf & Zhuang, *comb. nov.*
 = *Peziza apicalis* Berk. & Br., *J. Linn. Soc., Bot.* **14**: 106. 1873.
 = *Pseudohelotium apicalis* (Berk. & Br.) Sacc., *Syll. Fung.* **8**: 304. 1889.
 = *Mollisiella apicalis* (Berk. & Br.) Sacc. & Sacc. in Sacc., *Syll. Fung.* **18**: 64. 1906.
 = *Helotiopsis apicalis* (Berk. & Br.) Höhn., *Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1*, **119**: 623. 1910.

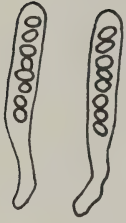
NOTES: A description and illustration of the excipulum of the apothecium of this species on a moss (*Rhacomitrium sulcatum*) from Ceylon is provided in Sherwood and Korf (1976). We provide here also an illustration of the ascus and ascospores (FIG. 4) from the holotype specimen on deposit at Kew. See below, in the notes on *Pithyella hypnina*, for a discussion of how these two species may or may not differ.

FIGS. 2-4. Species of *Pithyella* and of *Claussenomyces*. 2. *Pithyella erythro stigma* (holotype): a. diagrammatic sketch of apothecium in section; b. two asci containing ascospores; c. seven ascospores; d. anatomy of excipulum and stipe. Magnifications: a $\times 100$, b-d $\times 1000$. 3. *Claussenomyces hydnicola* (holotype): a. ascus with vermiform, young ascospores; b. ascoconidia forming eight balls within ascus; c. two mature ascospores; d. mature ascospore budding ascoconidia and three ascoconidia to one side. Magnification: all $\times 1000$. 4. *Pithyella apicalis* (holotype): a. two ascospores; b. ascus and ascospores. Magnification: all $\times 1000$.

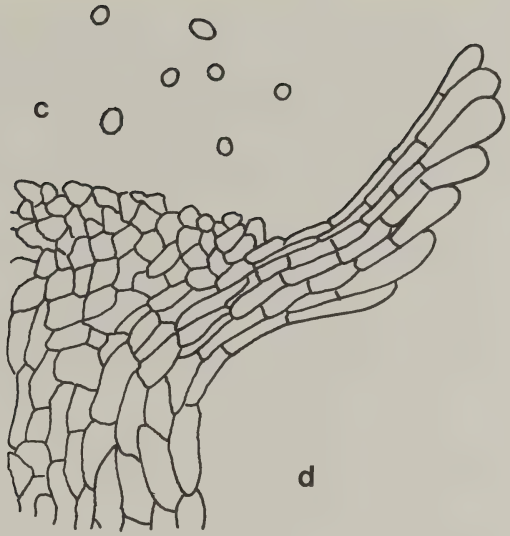


a

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b

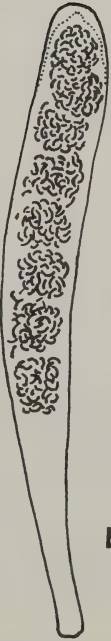


c

d



a



b

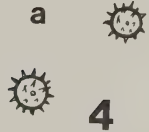
3



c



d



a

4



b

3. PITHYELLA ERYTHROSTIGMA (Berk. & Br.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.
 ≡ *Peziza erythrostigma* Berk. & Br., Ann. Mag. Nat. Hist., ser. 3, **18**: 126, pl. 4, fig. 31. 1866.
 ≡ *Dasyscyphus erythrostigma* (Berk. & Br.) Sacc., Syll. Fung. **8**: 453. 1889 ('*Dasyscypha*').

NOTES: We examined the holotype of this fungus, deposited at Kew. It is a tiny, rather long-stipitate species, yellow-orange (when dry), which occurs on the perithecia of *Chaetosphaerella phaeostroma* (Dur. & Mont.) Müller & Both. We cannot find a better genus than *Pithyella* in which to place this fungus. Unlike the type species of *Pithyella*, the ascospores of this fungus are not distinctly marked, and in this regard this species resembles *P. anonyma*, the other fungicolous species we accept in this genus. The original authors illustrated (FIG. 1D) the morphology of apothecium and asci (Berkeley & Broome, 1866); we provide some anatomical details here (FIG. 2).

4. PITHYELLA HYPNINA (Quélet) Boudier, Icones Mycologicae, Liste Préliminaire, p. [4]. 1904.
 ≡ *Mollisia hypnina* Quélet, Bull. Soc. Bot. France **25**: 291. 1879.
 ≡ *Barlaea hypnina* (Quélet) Sacc., Syll. Fung. **8**: 115. 1889.

NOTES: The original description of this moss-inhabiting species from the Jura mountains (Quélet, 1879) is very brief, and notes that the ascospores are "subtilement aculéolée." Quélet (1881) added an illustration (FIG. 1A) showing the tiny ascospores marked with spines. When Boudier (1885) established the genus *Pithyella* on this species, he remarked, "mais les spores sont lisses." In his Icones Mycologicae, Boudier [1905: pl. 519 (n° définitif) = pl. 189 (n° provisoire)] illustrated the species with smooth ascospores (FIG. 1B), from material "récolté en février à Hérimoncourt, dans le Jura," and provided an identification of the hypnaceous host: *Hylocomium oakesii*. He later (Boudier, 1911) noted this to be authentic material sent to him by Quélet "qui me les a adressés en février." As indicated above, we believe that Boudier erred in not observing the spore markings, noted by Quélet, and seen by us on all moss-inhabiting material we have examined. Regrettably we have been unable to find the Quélet specimen from which Boudier prepared his plate, and no other specimen of Quélet's that might represent type or authentic material is known.

Pithyella hypnina and *P. apicalis* are at best critically distinct. For *P. hypnina* Quélet (1879) indicated ascospores were 3.0-

4.0 μm in diam, while Boudier (1911) gave ascospore measurements of 3.0-3.5 μm in diam, with asci 65-70 $\times$ 18-20 μm . Berkeley and Broome (1873) described *P. apicalis* with ascospores 3.0-4.0 μm in diam, while von Höhnelt (1910) and Sherwood and Korf (1976) gave ascospores as 4.0-5.0 μm in diam and asci as about 60 $\times$ 6.0 μm for that species. The difference in spore size seems within the normal range of measurement error, but the asci of Quélet's species ought to be three times as wide as those of Berkeley and Broome's species if we are to believe Boudier's description. Boudier's (1905) plate, however, does not agree at all with his later description. On the plate the length/width ratio for asci ranges between 6.4 and 8.3, while the text would yield ratios between 3.25 and 3.9, very wide asci indeed. Some of the errors in Boudier's measurements have been commented upon previously (Brummelen, 1969), and using the scale reproduced in that paper the asci in the Boudier plate are calculated to be only 9.0-10.0 μm wide. This is still half again as wide as the asci described for *Pithyella apicalis*, and we thus tentatively accept two species differing at least in this one character. Should they prove eventually to represent a single taxon, *P. apicalis* will have priority.

5. *Pithyella jenkinsii* (Sherw. & Korf) Korf & Zhuang, *comb. nov.*
 = *Helotiopsis jenkinsii* Sherw. & Korf, Mycotaxon 3: 321. 1976.

NOTES: A description and illustrations (FIG. 1F) of this species, which grows on roots of an unidentified fern in Mexico, were provided by Sherwood and Korf (1976). The holotype is on deposit in CUP.

Excluded species:

1. PITHYELLA AUSTRIACA (Höhn.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.
 (Basionym: *Mollisiella austriaca* Höhn., Ann. Mycol. 1: 396. 1903.)

NOTES: This appears to be a later synonym of *Lachnellula theiodes* (Cooke & Ell.) Sacc., discussed in some detail by Korf (1962). We have examined the holotype in FH.

2. PITHYELLA HAMATA Chenantais, Bull. Soc. Mycol. France 34: 39, pl. 3, fig. 3. 1918.

NOTES: As is clear from the description and illustrations (FIG. 1E), this is a species of *Unguiculariopsis* on *Rhytidhysterium*. The type specimen was apparently on deposit at Nantes (NTM), and along with the other discomycetes was destroyed during World War II. It will be discussed further in the junior author's monograph of *Unguiculariopsis*.

3. PITHYELLA HYDNICOLA (Berk. & Br.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.

≡ *Peziza hydnicola* Berk. & Br., Ann. Mag. Nat. Hist., ser. 4, 7: 434, pl. 20, fig. 20. 1871.

≡ *Claussenomyces hydnicola* (Berk. & Br.) Korf & Zhuang, *comb. nov.*

NOTES: Examination of the holotype specimen on deposit at Kew reveals that this species, said to be on a fungus, *Hydnum ochraceum*, is a non-ionomidotic species of *Claussenomyces* Kirschst. The apothecia are about 1 mm in diam, and rehydrate greenish-black. The ascospores are narrow, vermiform, mostly $20-22 \times 2.5 \mu\text{m}$, with (5-) 9-13 transverse septa (FIG. 3c). The ascospores soon bud great quantities of bacillar or slightly curved ascoconidia approximately $0.5 \times 1.5 \mu\text{m}$, which may fill the 8-spored ascus (FIG. 3b, d). Asci are approximately $88-100 \times 7.0-8.8 \mu\text{m}$, and borne from croziers.

In some of the asci, all possibly at a certain stage of development, the ascoconidia are arranged in a series of eight distinct balls (FIG. 3b), which Berkeley and Broome mistakenly thought to be eight spherical ascospores. They illustrated these (FIG. 1C) and also described and illustrated conidia said to be "0.0001-0.00015" inches long (*i.e.*, about $2.5-3.7 \mu\text{m}$ long). There is no mention of where the conidia were produced, and they probably were ascoconidia floating free in their mounts. Those measurements, however, are about twice as long as the ascoconidia we found. It is clearly not one of the *Claussenomyces* species described by recent authors (Korf & Abawi, 1971; Ouellette & Pirozynski, 1974; Beaton & Weste, 1978; Ouellette & Korf, 1979; Hawksworth & Sherwood, 1981), and we transfer it here.

4. PITHYELLA HYPNORUM (Fr. : Fr.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.

(Basionym: *Peziza hypnorum* Fr. : Fr., Syst. mycol. 2(1): 149. 1822.)

NOTES: This is apparently a lost species. From Fries's brief description we can hardly place this fungus. It could conceivably be an older name for *Pithyella apicalis* or *P. hypnina*.

5. PITHYELLA ILICINCOLA (Berk. & Br.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.
(Basionym: *Peziza ilicincola* Berk. & Br., Ann. Mag. Nat. Hist., ser. 3, 7: 450, pl. XVI, fig. 17, 1861.)

NOTES: This is the type species of the genus *Unguiculariopsis*. We have examined the holotype specimen, which is on deposit at Kew.

6. PITHYELLA LIVIDA (Bacc.) Boud., Hist. classific. discomyc. Europe p. 125. 1907.
(Basionym: *Pseudohelotium lividum* Bacc., Nuovo Giorn. Bot. Ital. 11: 419. 1904.)

NOTES: This fungus is a species of *Unguiculariopsis*. The junior author has examined the type specimen, which is on deposit at Firenze.

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Dr. Peter Döbbeler, Munich, in providing us comments on moss-inhabiting discomycetes, and of the curators and directors of the Farlow Herbarium, Cambridge (FH), the Herbarium Universitatis Florentinae, Firenze (FI), the Botanical Museum, University of Helsinki (H), the Royal Botanic Gardens, Kew (K), and the Muséum d'Histoire Naturelle, Nantes (NTM) for the loan of type specimens or information on these. Dr. Martha A. Sherwood-Pike kindly served as pre-submission reviewer.

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NEW BRAZILIAN HETEROBASIDIOMYCETES

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ABSTRACT

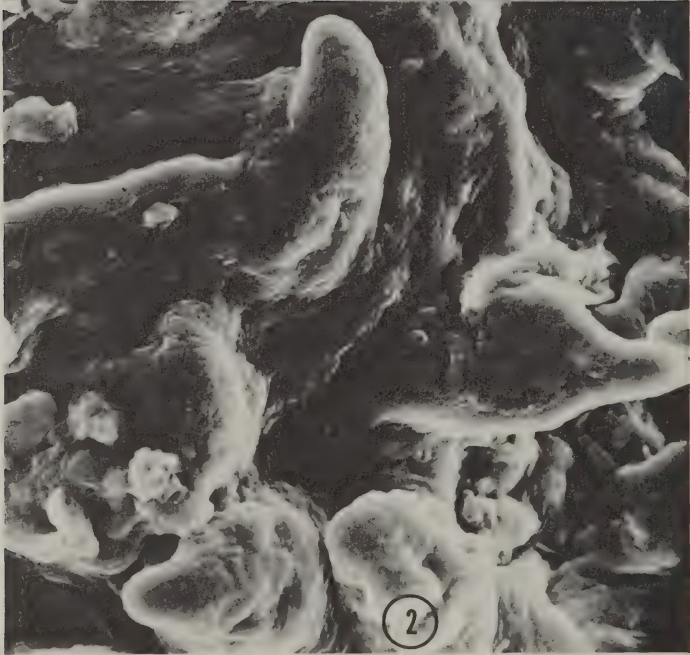
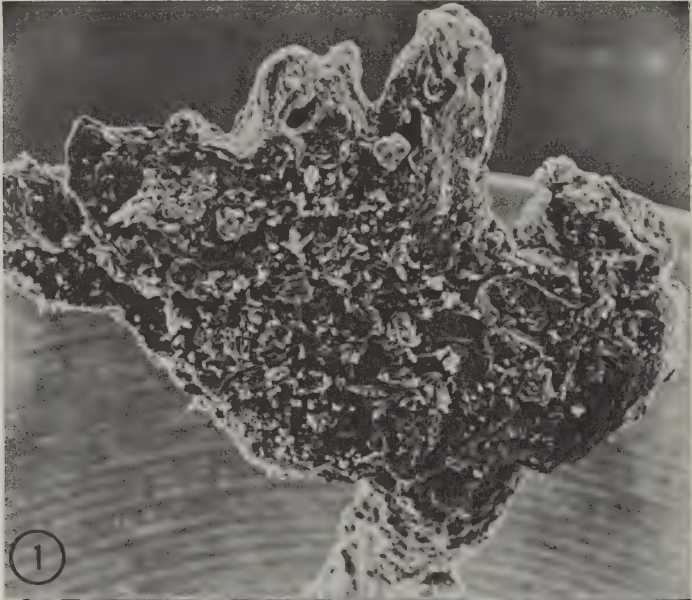
Three new species of Heterobasidiomycetes are reported from the Ilha de Maracá, Roraima, Brasil: *Dacryopinax crenata*, *Exidia maracensis*, and *Heterochaete bodmanii*. Other collections of Auriculariaceae, Tremellaceae, and Dacrymycetaceae are also listed.

Ilha de Maracá, located at 3°15'-3°35' N. Lat., 61°22'-61°58' W. Long., in the State of Roraima, is one of 16 biological stations designated by the Brazilian government as an ecological reserve. The riverine island, bounded by northern and southern branches of the Uraricoeira river, is one of the largest of such islands known, measuring approximately 65 x 25 km, constituting an area of 92,000 hectares. At present, only a small section at the eastern extremity of the island has been made accessible by trails cut through the forest. The limited access to the island, which requires special permission and carefully scrutinized credentials in order to carry out biological studies there is exemplary, and establishes a model much to be desired in many other regions of Brazilian Amazonia as well.

Dacryopinax crenata Lowy, sp. nov.

Fig. 1.

Fructificatio in humido elastico-gelatinosa, stipitata et pileata, aurantio-rubiginosa, sicca cornea, succina; pileo crenata, rugulosa, usque ad 4 mm late X 1 mm crassa; caulis subcylindraceus, rugosa, 10 mm alt X 1.5 mm crassa; hyphae enodosae; probasidia cylindracea, unicellularis, 15-20 x 3.0-3.5 μ m; metabasidia aseptata, bifurcata, 20-26 x 3-4 μ m; basidiosporae curvulo-cylindraceae, 8-10 x 3.5-4.0 μ m, postremo 1-septatae.



Fructification stipitate, pileate, rubbery gelatinous, rusty orange when fresh, drying dark amber, horny; pileus expanded, rugulose, up to 4 mm broad x 1 mm thick, with projecting lobules forming a crenate margin; stipe up to 10 x 1.5 mm, subcylindrical, coarsely and irregularly grooved; hyphae without clamp connections; probasidia cylindrical, unicellular, 15-20 x 3.0-3.5 μm ; metabasidia unicellular, furcate, 20-26 x 3.0-3.5 μm , producing thick, cylindrical sterigmata; basidiospores curved cylindrical, 8.0-10.5 x 3.5-4.0 μm , becoming 1-septate.

HOLOTYPE: Ilha de Maracá, Roraima, Brasil. On unidentified, decorticated wood. 9-VI-1986. Lowy 1671R. LSUM, INPA.

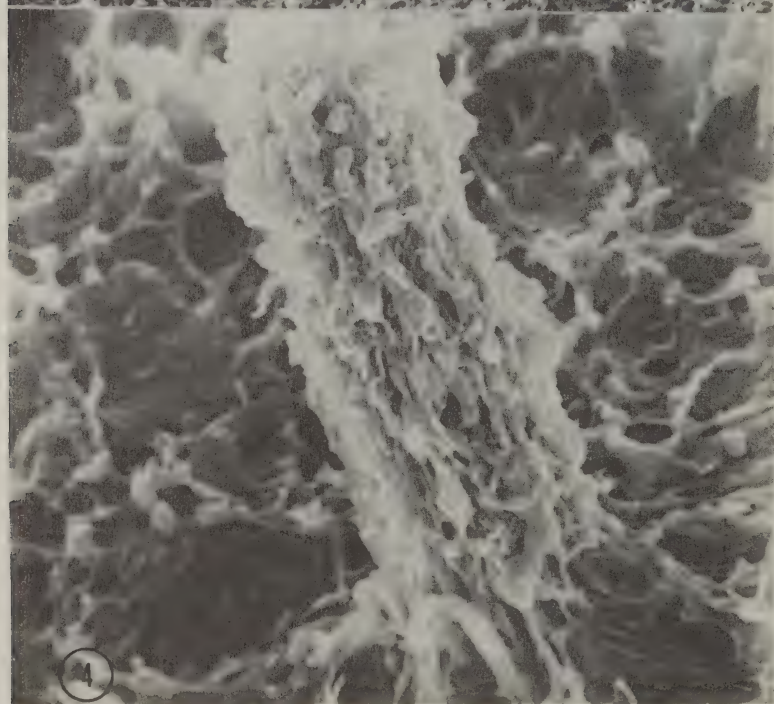
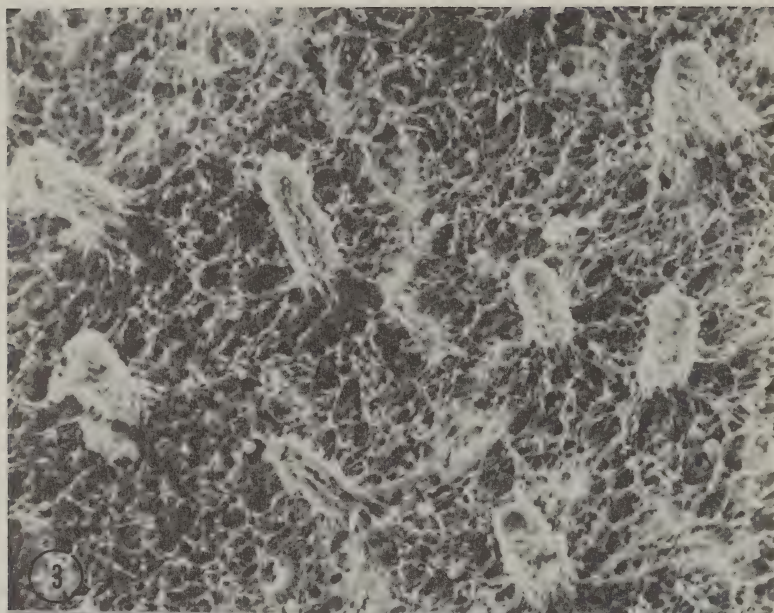
The genus Dacryopinax was established by Martin (1948) to include species differing from other members of Dacrymycetaceae by being "erect, stipitate and pileate, cupulate or spathulate when young, becoming fan-shaped or petaloid ...". Mature basidia of Dacryopinax, like other members of the family, are unicellular and bifurcate, the stout, elongate sterigmata (epibasidia sensu Martin) producing spore-bearing spicula (sensu Donk and Talbot; 1954, 1973) that pierce the hymenium, which is inferior. The pileus of D. crenata (Fig. 1) with its coarsely crenate margin is quite distinctive, although somewhat reminiscent of the deeply lobed, foliose pileus of D. indacocheae Lowy (1959). The pileus of D. crenata, however, is relatively small and thick, and free of hairs, whereas D. indacocheae has a thin pileus, and both pileus and stalk are conspicuously tomentose. D. indacocheae is illustrated in Flora Neotropica 6, 1971 (Fig. 28C). A key to the species occurring in the American tropics was published by Lowy (1981).

Exidia maracensis Lowy, sp. nov.

Fig. 2.

Fructificatio in humido cartilagineo-gelatinosa, foliosa, brunnea, 2.5 x 2.0 cm late x 1 mm crassa; sicca cornea, atrobrunnea; hymenio inferiori, convoluta, cum papillis numerosis, 105-120 x 25-35 μm ; hyphae enodosae;

-
- Figs. 1-2. 1. Pileus and part of stipe of Dacryopinax crenata. X 25.
2. Papillae crowded on hymenial surface of Exidia maracensis. X 500.



probasidia subglobosa, 10.0-12.5 μm diam; metabasidia cruciatim septata, 14.5-18.0 x 10.0-12.5 μm diam; basidiosporae allantoideae, 5.5(-6.5) x 3.5 μm , per repetitionem germinantes.

Fructification tough cartilaginous-gelatinous, foliose, up to 2.5 x 2.0 cm x 1 mm thick, light brown, drying darker, horny; hymenium inferior, convolute, bearing numerous papillae, 105-120 x 25-35 μm ; hyphae without clamp connections; probasidia unicellular, globose to subglobose, 10.0-12.5 μm diam; metabasidia cruciate septate, 14.5-18.0 x 10.0-12.5 μm diam; basidiospores allantoid, 5.5(6.5) x 3.5 μm , germinating by repetition.

HOLOTYPE: Ilha de Maracá, Roraima, Brasil. On unidentified, decorticated wood, 24-VI-1986. Lowy 1723R. LSUM, INPA.

Macroscopically, this robust species of Exidia bears a superficial resemblance to some species of Tremella, but the papillate hymenium (Fig. 2) excludes it from that genus. Microscopically, the basidiospores are typically exidioid, being curved-cylindrical, as opposed to the subglobose or ovoid basidiospores of most Tremella spp. Noteable, however, in this Exidia, are the small basidiospores which measure approximately half the length of most species of the genus I have examined, both tropical and temperate.

Among tropical species of Exidia that I have reported (Lowy 1971), only E. recisa is foliose to erect lobate, but differs from the new species in virtually all other significant characteristics. To cite the major ones: E. recisa dries thin and black, with relatively scattered, black papillae. Microscopically, it is characterized by its large spores (about 12-15 μm x 4-5 μm), and clamp connections.

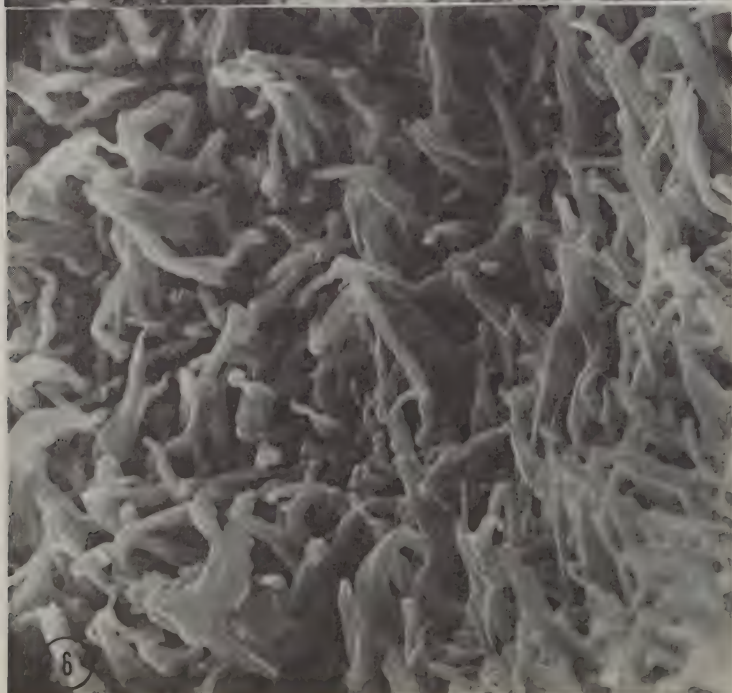
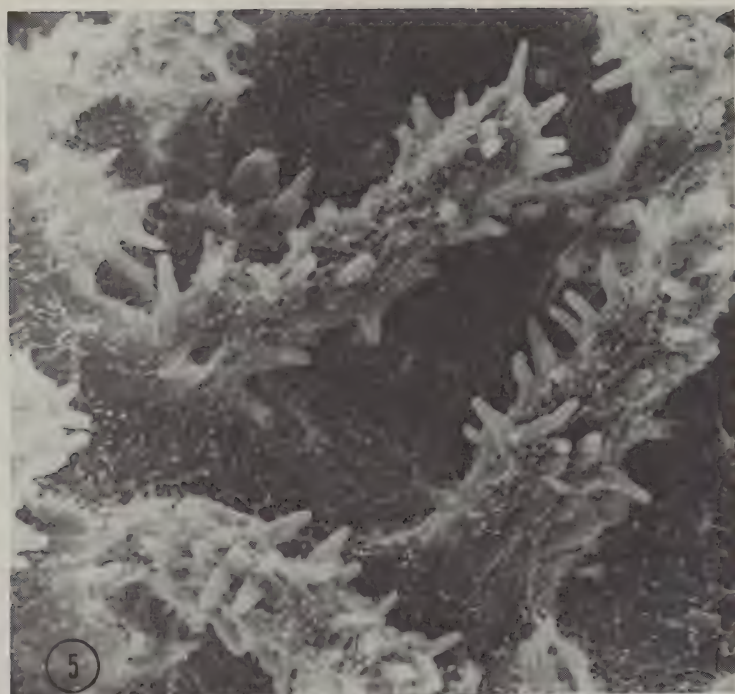
Heterochaete bodmanii Lowy, sp. nov.

Figs. 3-4.

Fructificatio resupinata, tenua, arida, rosaria; sicca concolorata; in sectione 60-80 μm crassa; setulis numerosis, cylindricis, subhymenio emergentibus, 100 x 35 μm ; hyphae

Figs. 3-4. 3. Distribution of pegs on hymenial surface of Heterochaete bodmanii. X 25.

4. Peg detail. X 200.



enodosae; probasidia globosa vel subglobosa; 10.0-12.0 μm diam; metabasidia pryformis, cruciatim septata, 20.0-25.5 x 6.0-7.5 μm ; basidiosporae curvulo-cylindratae, 12.0-15.0 x 6.0-7.5 μm , per repetitionem germinates.

Fructification resupinate, arid, light pinkish when fresh, drying concolorous, 60-80 μm thick; hymenial pegs numerous, cylindrical, up to 100 x 35 μm , arising from subhymenium; hyphae without clamp connections; probasidia unicellular, globose to subglobose, 10.0-12.0 μm diam; metabasidia pyriform, cruciate-septate, 20.0-25.5 x 6.0-7.5 μm ; basidiospores curved-cylindrical, 12.0-15.0 x 6.0-7.5 μm , germinating by repetition.

HOLOTYPE: Ilha de Maracá, Roraima, Brasil. On unidentified, decorticated wood, 6-VI-1986. Lowy 1233R. LSUM, INPA. The species is named in honor of the late Sr. Mary Cecilia Bodman.

The most reliable reference to the morphology and taxonomy of the genus Heterochaete is the monograph by Bodman (1952). Her diligence resulted in the acceptance of 29 species, 25 of which were originally reported from tropical habitats. Many are still known only from their type localities. H. bodmanii appears to be closest to H. andina Pat. & Lag. as described by Bodman, but differs in several key characters, among these being the lack of clamp connections and sterile subhymenial elements, the absence of gelatinization in both pegs and hymenium, and the distinctly 4-celled basidia. The pegs (Figs. 3-4) are abundant and closely spaced, about 100 μm apart. For a comparison with the gross morphology (SEM photograph) of the pegs of H. maculata Lowy, reference may be made to Lowy (1977).

Sterile elements, including papillae, pegs, and cystidia are often sufficiently distinctive to assist in the identification of some Heterobasidiomycetes, and occasionally they may be diagnostic on the genus or species level. Scanning electron micrographs of Auricularia fuscosuccinea hairs (Fig. 6) and of a cystidiophore of Heterochaetella cystidiophora (Fig. 5), both collected on Maracá island, are

Fig. 5. Cystidiophores with cystidia on hymenial surface of Heterochaetella cystidiophora. X 500.

Fig. 6. Hairs on abhymenial surface of Auricularia fuscosuccinea. X 500.

provided to indicate significant morphological differences among conspicuous sterile elements of the 5 genera illustrated.

Additional collections of tremellaceous fungi from Maraca are listed below.

AURICULARIACEAE

Auricularia delicata (Fr.) Henn.

Lowy 1490R, 12-VI-1986; Lowy 2121R, 2-VII-1986.

A. fuscossuccinea (Mont.) Farl.

Lowy 1217R, 5-VI-1986; Lowy 1375R, 9-VI-1986; Lowy 1440R, 11-VI-1986; Lowy 1491R, 12-VI-1986; Lowy 1497R, 13-VI-1986; Lowy 1803R, 24-VI-1986; Lowy 1833R, 25-VI-1986; Lowy 1858R, 25-VI-1986; Lowy 1928R, 26-VI-1986; Lowy 2170R, 3-VII-1986; Lowy 2151R, 2-VII-1986.

A. mesenterica Pers.

Lowy 1255R, 6-VI-1986.

Helicogloea lagerheimii Pat.

Lowy 1216R, 5-VI-1986; Lowy 1530R, 13-VI-1986.

TREMELLACEAE

Exidia nucleata (Schw.) Burt

Lowy 1255R, 6-VI-1986.

Heterochaetella cystidiophora Lowy

Lowy 1648R, 18-VI-1986; Lowy 1652R, 18-VI-1986.

Pseudohydnum gelatinosum (Fr.) Karsten

Lowy 1769R, 24-VI-1986.

Tremella fibulifera Möller

Lowy 1735R, 24-VI-1986; Lowy 2122R, 2-VII-1986.

DACRYMYCETACEAE

Calocera cornea Fr.

Lowy 1978R, 28-VI-1986.

Dacryopinax elegans (Berk. & Curt.) Martin

Lowy 1907R, 26-VI-1986.

D. spathularia (Schw.) Martin

Lowy 1343R, 8-VI-1986; Lowy 1215R, 2-VI-1986.

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MYCOTAXON

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DENDROSPORA POLYMORPHA SP. NOV. A NEW HYPHOMYCETE FROM SPANISH STREAMS

by

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Resumen: Se describe en cultivopuro *Dendrospora polymorpha* sp. nov. (Moniliaceae, Deuteromycotina), procedente de conidios en espumas del río Mundo, (Albacete, España). Se contrasta con conidios referidos desde Inglaterra, Noruega, Nueva Zelanda, Subártico sueco y España Nororiental.

Conidia of the species described below have been illustrated from England (INGOLD, 1975), Norway (BRATHEN, 1982), New Zealand (AIMER & SEGEDIN, 1986) and the Subarctic (MARVANOVÁ & MULLER-HAECKEL, 1980). They have also been detected too in the Catalanian Pyrenees (DESCALS, in press). It has been isolated in the course of a survey of hyphomycetes from aquatic habitats in S.E. Spain. It is therefore probably very widely distributed over a range of climates. Its substrate is so far unknown, although the fungus appears to be associated with the decomposition of allochthonous organic matter in freshwater habitats.

Dendrospora polymorpha Roldán & Descals sp. nov.

Coloniae in agar Nawawii (1974) albae lente crescentes, glabrae, hyphae 1.5-2 μ m latae. Sporulatio copiosa super partes culturae non axenicae submersas in aqua destillata, turbulenta. Conidiophora mononematosa, apicalia vel lateralialia, semimacronematosa, simplicia vel parce brachiata; axis principalis usque ad 120 x 3.5 μ m, brachia monopodialia, acropetalia. Cellulae conidiogenae solitariae, apicales, incorporatae 8-14 x 3.5 μ m, monoblasticae, indeterminatae. Conidia solitaria, apicalia, aut simplicia, aut typice monopodialiter brachiata, brachia in planis variis. Axis principalis curvatus (vel rectus vel sigmoideus), subfusioideus vel irregulariter cylindricus, 50-120 x 4-6 μ m, usque ad 8-septatus, cicatrix truncata; brachia 1-2 (in spuma usque ad 5 primaria, vicissim cum paucis brachiis secundariis), virga saepe propius cicatricem; plus-minusve perpendicularia, recta vel subcurvata, irregulariter cylindrica vel subclavata, basi lata, 20-120 x 4-5 μ m. Germinatio in aqua et spuma et in agar cum antibioticis.

Dendrospora polymorpha Roldán & Descals sp. nov. (Figs. 1-4).

Colony (on NAWAWI'S medium, 1974) white, slightly raised at the centre (pale cream on malt agar 2%), reaching 3.4 cm diam/5 weeks at room temperature, glabrous, hyphae 1.5-2 μ m wide. Sporulation: slices of culture submerged in sterile distilled standing water for 12 days at

room temperature (fluctuating 16-19°C) remained vegetative, but in turbulent non-axenic distilled water numerous sparsely branched conidia were produced after 4 days. Conidiophores mononematous, apical (or lateral), semimacronematous, simple or branching with sparse and cymose axis clavate, 10-120 x 3.5 μm (at apex). Conidiogenous cells solitary, apical, integrated, 8-14 x 3.5 μm (at apex), monoblastic, indeterminate. Conidia solitary, apical, simple or more typically branched monopodialy and in more than one plane; main axis curved (or straight or sigmoid), subfusoid to irregularly cylindrical, 50-120 x 4-6 μm , up to 8-septate, scar truncate, branches 1-2 (in stream foam up to 5 primary branches, sometimes with a few secondary branches), one branch often near the scar, more or less perpendicular to their subtending element, straight to subcurved, irregularly cylindrical to obclavate, 20-120 x 4-5 μm . Conidia germinate readily in liquefied foam and on isolation media supplemented with streptomycin and penicillin (DESCALS & al. 1977).

Collections: single-conidium isolate from foam in Los Chorros del río Mundo, Albacete (UTM WH4957) (Descals & Roldán, Dec. 19, 1985) (MA FUNGI 16387, holotype, ex Descals D93-A-27 = isotype); stream foam from Vall de Ribes, Catalonia, Spain, Descals Feb. 1985 (Descals D-4, D-13, D-19); foam from río Madera, Albacete (Roldán Aug. 1985, A-17); arroyo Celada, Albacete (Roldán Nov. 1985, A-27); río Borosa, Jaén (Roldán Nov. 1985, A-62); río Bacaes, Almería (Roldán Oct. 1985, A-68) and río Cuervo, Cuenca (Roldán Jan. 1986, A-85).

Dr. L. Marvanová, who kindly reviewed this paper and allowed us to read a manuscript in press, remarked on the similarity between isolate D93-A-27 of D. polymorpha and her Pachycladina mutabilis gen. et sp. nov. inéd. (Marvanová, 1986). Three features concur: 1- the distal portion of the conidiophores (= "ramoconidia ?") and conidial axes often undergo a secondary process of schizolysis (breaking up into smaller portions); 2- there frequently is a parabasal conidial element, which seems to appear after the normal branching sequence is completed; 3- overall dimensions of the conidiogenous apparatus (including conidial) of both species match. However, in D. polymorpha conidial branches are as a rule more numerous (at least in nature) and always arranged alternately, often being in two orders, and with rounded apices; while in P. mutabilis conidial branches don't exceed three in number, there are no records of secondary branching, two branches characteristically arise from either side of a septum on the main axis (as in Fontanospora), the elements are generally long-fusoid or taper distally and conidial cells tend to be slightly swollen.

The clasification of D. polymorpha is somewhat problematic. Its highly polymorphic conidia could be assignable to Varicosporium, Tricladium or the Dendrospora-Dendrosporomyces complex, all of which have become increasingly ill-defined in recent years.

Conidia of Varicosporium elodeae (type sp.) display predominantly unilateral alternate branching associated with loss of apical dominance of the main axis, frequently present in our species too; but in the former conidia are acropleurogenous and secede by abstriction, while in D. polymorpha the basal septum is broad and conidia are only produced apically.

There are examples of frequent secondary branching in several Tricladium species (e.g. T. patulum, T. castaneicola and T. terrestre) but

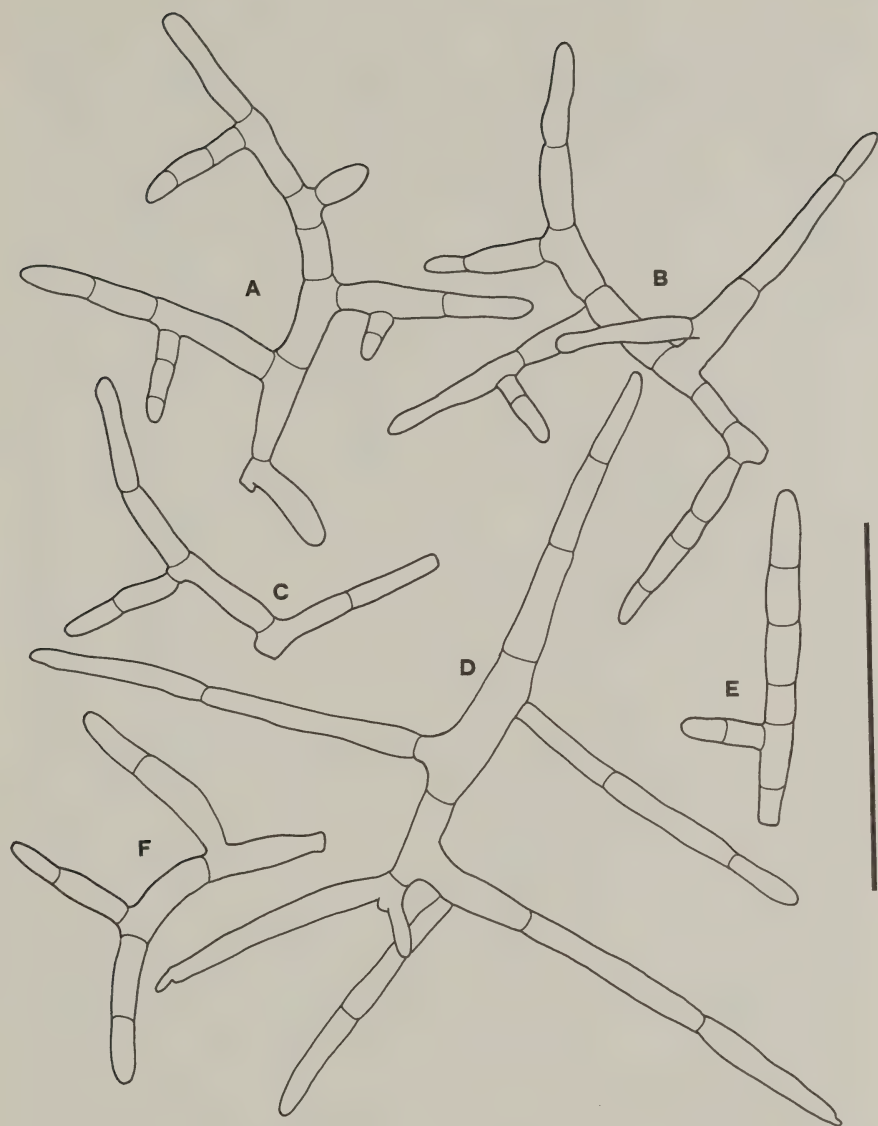


Fig. 1. Conidia from stream foam (Roldán A-85), (lactofuchsin mounts). Notice basal branch in A and B. D: Incipient germination. C: Part-conidium. (Bar = 50 μ m).

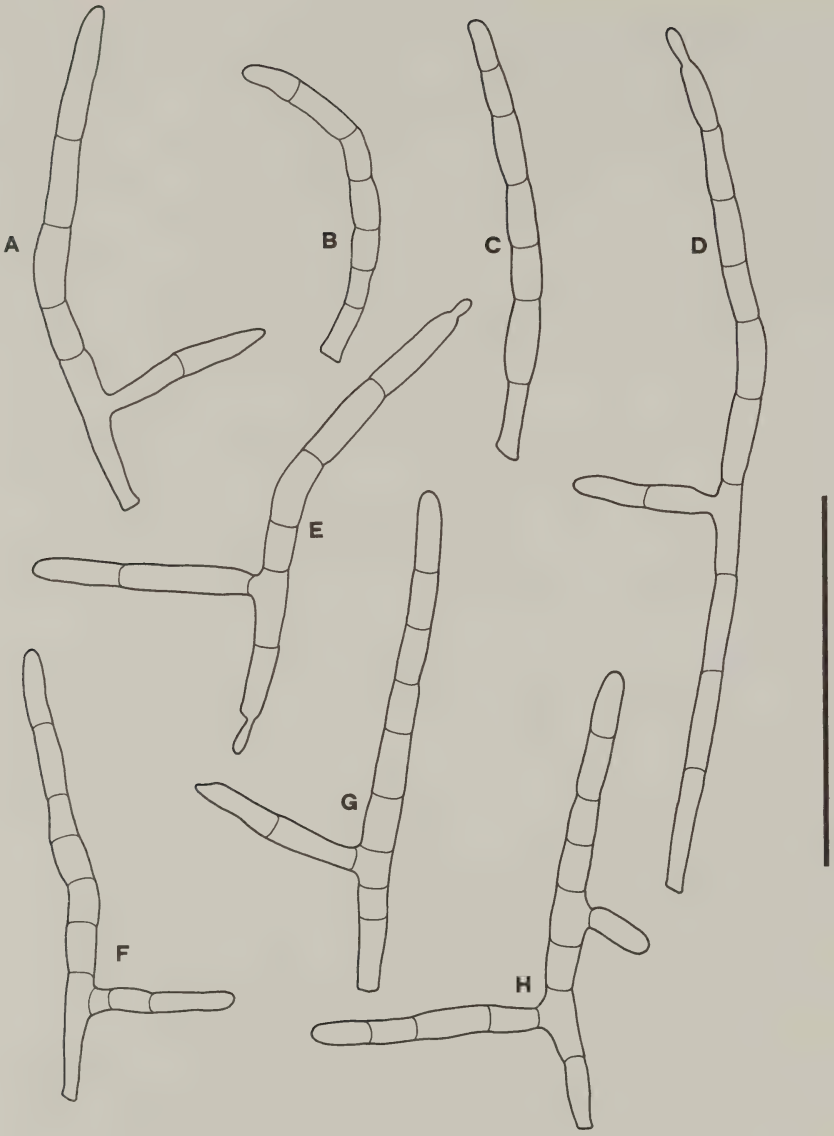


Fig. 2. Conidia from isolate (Descals D93-A27) (lactofuchsin mounts). (Bar = 50 μ m).

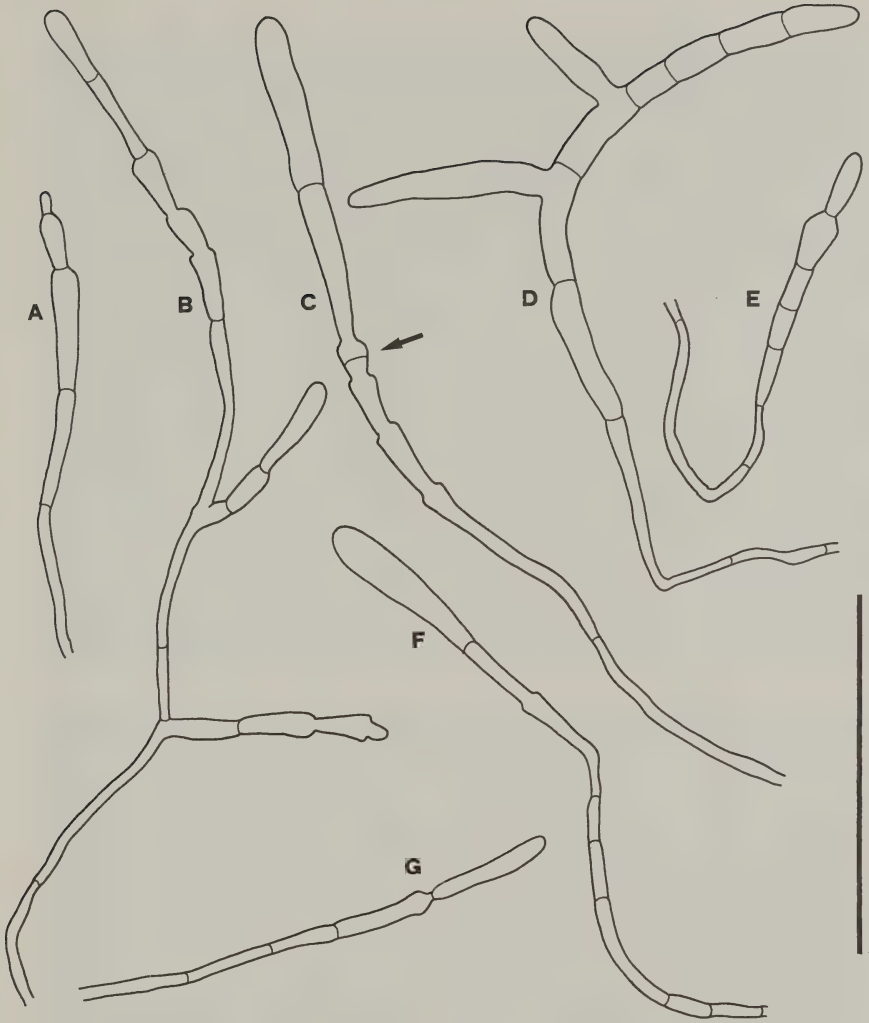


Fig. 3. Conidiophores from isolate (Descals D93-A27) (lactofuchsin mounts). Notice repeated indeterminate elongations of the conidiophores. Arrow shows a septum laid down during this process. (Bar = 50 μ m).

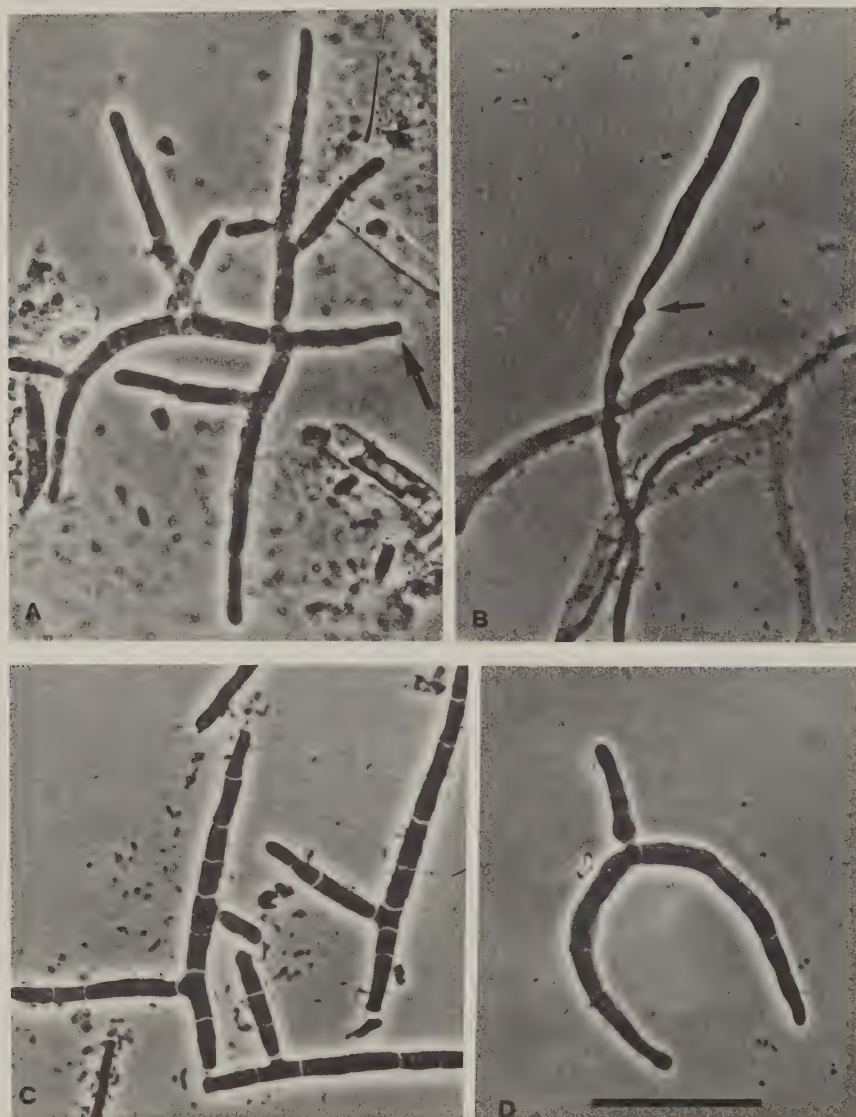


Fig. 4. A) Conidia from stream foam. Arrow shows the scar. B) Conidiophore. Arrow shows percurrent elongations. C,D) Conidia from culture. (Lactofuchsin mounts). All to same scale, bar = 40 μ m.

this is definitely not a characteristic of T. splendens (type sp.). On the other hand, conidiophore morphology and details of conidiogenesis of the latter are very similar to those of D. polymorpha. Dolipore septation has not been detected with light microscopy, i.e.: staining in ammoniacal Congo Red did not yield the swellings at the septal pores, which would suggest affinities with Dendrosporomyces, an anamorph of basidiomycetes. Until this is verified with electron microscopy, our fungus appears to be most closely allied with Dendrospora. D. erecta (type sp.) displays more or less verticillate conidial branching, not seen in D. polymorpha; but this is less evident in other species in the genus, such as D. nana Descals, where branching also tends to be more asymmetrical; in fact, this is a border species approaching Varicosporium and Pleuropedium. On the other hand, conidiogenesis clearly matches that of D. erecta. Within Dendrospora, D. polymorpha, with its alternate conidial branches unstricted at the insertion, is quite unmistakable, differing from its closest relative, D. nana, in conidial size and in the absence of lateral conidiogenesis.

ACKNOWLEDGMENTS

We should like to thank Drs. L. Marvanová and J. Webster for reviewing this manuscript.

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NEW HYPHOMYCETES FROM SANTIAGO RIVER (BUENOS AIRES PROVINCE, ARGENTINA)

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SUMMARY

Five new species from Santiago river namely: Dictyochaeta gamundii; Isthmolongispora asymmetrica; Kostermansinda minima; Phaeotrichoconis aquaticus and Phaeotrichoconis minigelatinosum are herein described.

Among the mycological investigations carried out at the Spegazzini Institute on the Santiago river (Argentina) there is a project to study the influence of industrial pollution and human activity, with the purpose of improving the environment and water quality. Five new species of Hyphomycetes are described found on dead leaves and bark collected on the water surface in the Santiago river. Only three of them were isolated in pure culture, and attempts at isolating the others in pure culture were unsuccessful. The following description concerns observation on natural media.

Exsiccata are available at the Spegazzini Institute (LPS).

Dictyochaeta gamundii Arambarri et Cabello sp. nov. Fig 1-5

Mycelium in substrato immersum, e hyphis crasse tunicatis, ramosis septatis, subhyalinis vel pallide brunneis compositum. Setae singillatim vel gregatim ortae, rectae, crasse tunicatae, laeves ad 6-septatae, ad basim obscure brunneae, ad apicem pallide brunneae vel subhyalineae, usque 350 um longae, e basi 5 um lata ad apicem 4 um lata attenuatae. Conidiophori macronemati, mononemati, simplices, recti, septati, basim obscure brunneae apicem pallide, crasse tunicati, laeves, 150-250 x 5-6 um. Cellulae conidiogenae phialidicae, integratae, terminales, subhyalinis vel pallide brunneis, paulum lageniformes ad apicem tenuites ad basim crasse tunicatae, 25-50 x 3.5-4.5 um. Collarula conspicua ad marginem tenuiter, sympodialis, 5 um diam. Phialoconidia setulis ornata, hyalina, paulum arcuata, symmetrica 16-20 x 2-3 um. Setulae 10-15 um.

Ex cortice putrida, río Santiago, Buenos Aires, holotypus LPS 44133.

Mycelium immersed in the substrate, composed of thick-walled, branched, septate, subhyaline to light-brown hyphae. Setae arising singly or in groups, erect, thick-walled, smooth up to 6-septate, dark brown at the base to subhyaline in the apex, up to 350 μm long, tapering from 5 μm wide at the base to 4 μm at the apex. Conidiophores macronematous, mononematous, simple, septate, dark-brown at the base to subhyaline in the apex, thick-walled, smooth, 150-250 x 5-6 μm . Conidiogenous cells phialidic integrated, terminal, subhyaline to light brown, slightly lageniform thin-walled at base 25-50 x 3.5-4.5 μm . Collarettes conspicuous, distally thin-walled, 5 μm diam. Phialoconidia with setulae, hyaline, slightly curved, symmetrical 16-20 x 2-3 μm . Setulae 10-15 μm .

The species more closely related are D. fertilis (Hughes et Kendrick) comb. nov. and D. assamica (Agnihothrudu) Arambarri, Cabello et Mengascini. D. gamundii differs from the first by the size of the conidia that are larger in our species, (D. fertilis 9-15 x 2-3 μm : Hughes and Kendrick, 1968) and the conidiophore is also longer in D. gamundii where is quite similar in most of the case with the length of the setae.

D. assamica as illustrated by us (Arambarri, Cabello and Mengascini, in press) differs from D. gamundii in that the setae are not polyphialidic; in this case also the size of the conidia are smaller.

Isthmolongispora asymmetrica Arambarri et Cabello sp. nov.
Fig. 6-8.

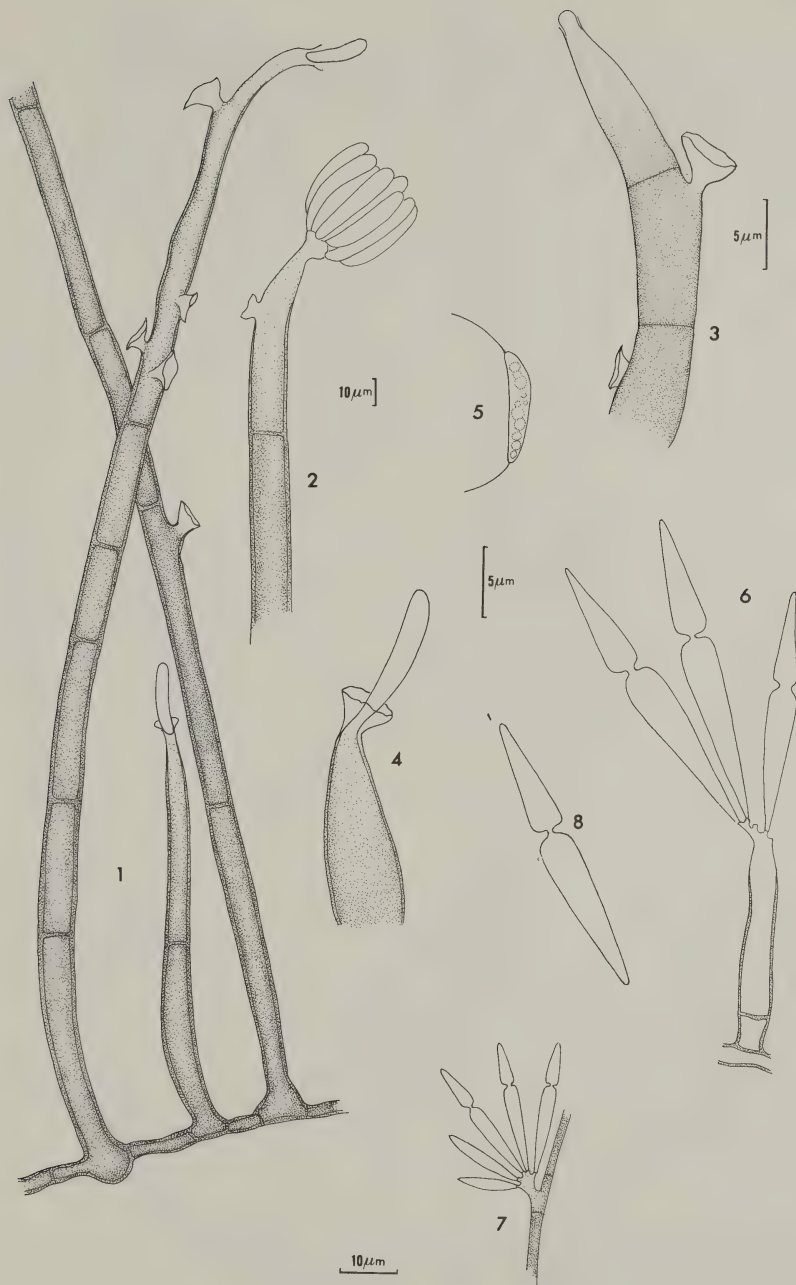
Mycelium ex hyphis ramosis, septatis, laevibus, subhyalinis 1-5 μm crasse compositum. Conidiophori macronemati, mononemati, simplices, recti, pauciseptati subhyalinis vel pallide brunneis, crasse tunicate, laeves, 5-20 x 2-3 μm . Cellulae conidiogenae polyblasticae, integratae, terminales, subhyalinis vel hyalinis sympodialiter prolifera, apice denticulata. Conidia fusiformia, asymmetrica, profunde constricta per isthmum connecta, laevia, hyalina 17-20 x 2-3 μm .

In foliis emortuis, río Santiago, Buenos Aires, holotypus LPS 44134.

Mycelium composed of branched, septate, smooth, subhyaline, 1-5 μm hyphae. Conidiophores macronematous, mononematous, simple, 1-2 septate, subhyaline to light brown, thick-walled, smooth, 5-20 x 2-3 μm . Conidiogenous cells polyblastic, integrated, terminal, subhyaline to light brown, sympodial denticulate, denticles cylindrical. Conidia fusiform, smooth, 0-septate with a deep constriction near the apex of conidium, 17-20 x 2-3 μm .

DICTYochaeta gamundii. 1. Conidiophore and conidiogenous cells; 2-3-4. Detail of conidiogenous cells; 5. Conidium.

Isthmolongispora asymmetrica. 6-7. Conidiophore and conidia; 8. Conidium



Our species differs from others described by Matsushima (1971, 1975) by the asymmetrical conidia. The most related species is I. minima but it has only one constriction in the middle of the conidia.

Kostermansinda minima Cabello et Arambarri sp. nov. Fig. 9-11.

Mycelium in substrato immersum, e hyphis crasse tunicatis, ramosis, septatis, brunneis compositum. Conidiophori macronemati, synnemati gregaria, recti, septati, basim obscure brunneae apicem pallide, crasse tunicati, laeves, 200-300 μ m longus et 13-15 μ m latus, ex hyphis parallelis pauce septatis 2-2.5 μ m crassis compositus. Cellulae conidiogenae monoblasticae, integratae, terminales, incrassatae. Conidia acrogena, solitaria, late ellipsoidea, glabra, muriformia, brunnea-subflava, 20-30 x 12-14 μ m.

Ex cortice putrida, río Santiago, Buenos Aires, holotypus LPS 44135.

Mycelium immersed in the substrate, composed of thick-walled, branched, septate, brown, hyphae. Conidiophores macronematous, synnematus, erect, dark brown at the base to subhyaline in the apex; thick-walled, smooth, 200-300 x 13-15 μ m, individual threads unbranched, 2-2.5 μ m. Conidiogenous cells monoblastic, integrated, terminal, determinate swollen. Conidia 20-30 x 12-14 μ m, solitary, acrogenous, simple, broadly ellipsoidal clavate, smooth, golden-brown, muriform, major part, 15-25 x 12-14 μ m with a smaller, non-septate, pale basal vesicle 4-5 μ m diam.

K. minima differs from K. magna (Boedijn) Rifai by the size of the conidia and the synnema, which are larger than in our species.

Phaeotrichoconis aquaticus Mengascini et Arambarri sp. nov. Fig. 12-13.

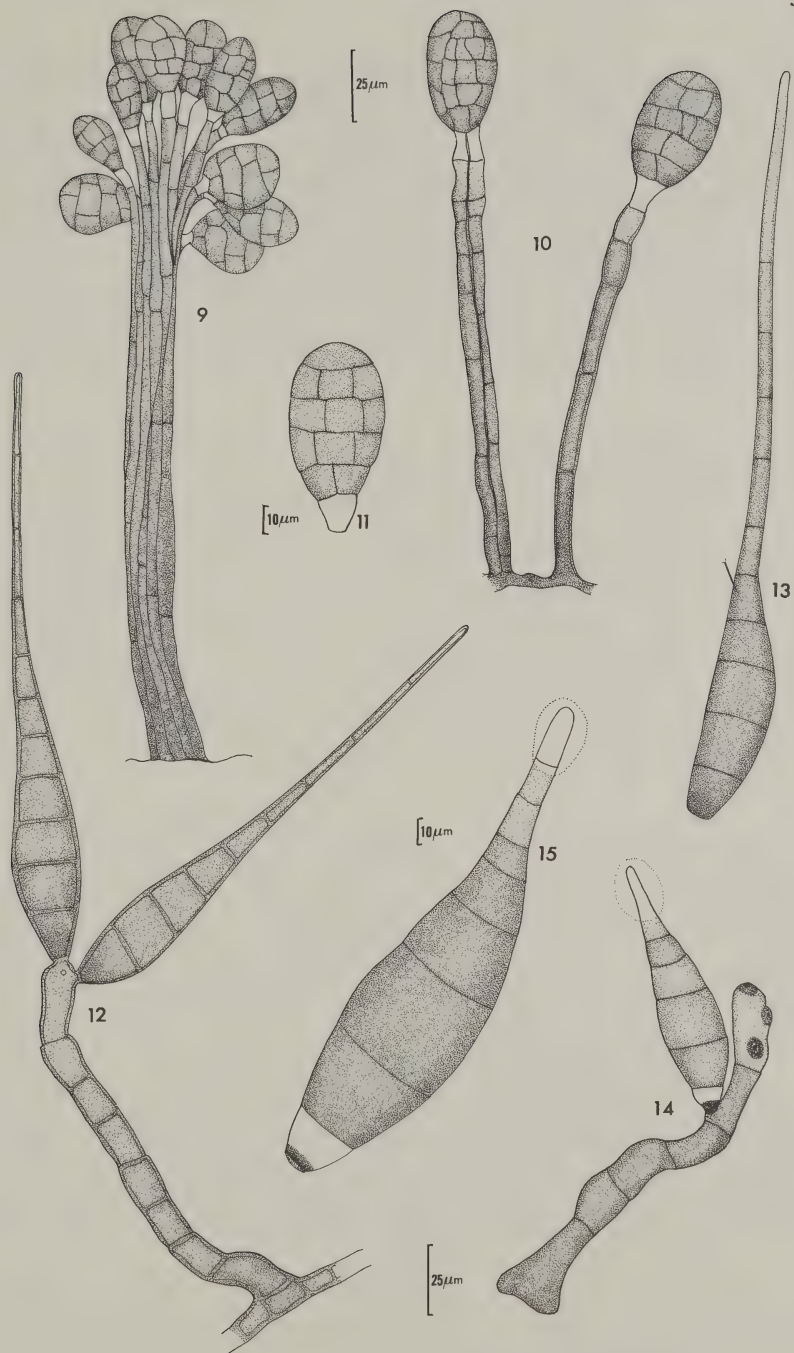
Mycelium immersum. Conidiophora macronematosa, mononematosa, solitaria, erecta, simplicia, septata, laevis, brunnea usque ad 150 μ m longae et 4-5.5 μ m crassa. Cellulae conidiogenae polytreticae, integratae, sympodiales, cicatricibus conidialibus pauce manifestis. Conidia solitaria, sicca, acrogena, obclavata, 5-6 septata, ad basim trunca ad apicem longo, rostro praedita laevia, brunnea, 110-150 x 10-11 μ m; rostrum rectum pauci septatum, pallide brunnea vel hyalinum usque ad 100 μ m longum et usque ad 2 μ m crassum.

In ramiis, emortuis, río Santiago, Buenos Aires, holotypus LPS 44136.

KOSTERMANSINDA MINIMA. 9. General aspect; 10. Detail of the conidiophore, conidiogenous cells and conidia; 11. Conidium.

PHAEOTRICHOCONIS AQUATICUS. 12. Conidiophore, conidiogenous cells and conidia; 13. Conidium.

PHAEOTRICHOCONIS MINIGELATINOSUM. 14. Conidiophore, conidiogenous cells and conidium; 15. Conidium.



Mycelium immersed. Conidiophores macronematous, mononematous, solitary, straight, simple, septate, with smooth walls, brown, up to 150 μm long and 4-5.5 μm thick. Conidiogenous cells polytretic, integrated, sympodial. Conidia solitary, dry, acrogenous, obclavate, transversely 5-6 septate, rostrate with a small scar at the base, smooth, brown, 110-150 x 10-11 μm ; beak straight 4-7 septate up to 100 μm long and 2 μm thick.

P. aquaticus is closely related to P. aurata Rambelli as described by Onofri et al. (1981) by the conidia and conidiophore form, but differs specially by the size of the conidia that is bigger in our species; the beak of the conidia meanwhile in our species is brown, in P. aurata is hyaline.

Phaeotrichoconis minigelatinosum Arambarri, Cabello et Mengascini sp. nov. Fig. 14-15.

Mycelium immersum. Conidiophora macronematosa, mononematosa, solitaria, erecta, simplicia, septata, laevia, brunnea-flava usque ad 160 μm longa et 6-8 μm crassa (ad basim 8-10 μm). Cellulae conidiogenae polytreticae, integratae, sympodiales, cicatricibus conidialibus manifestis 4-5.5 μm . Conidia solitaria, sicca, acrogena, obclavata, 5-8 septata ad basim trunca brunnea, 5-5.5 μm crassa, ad apicem brevi rostrata, brunnea-fusco brunnea, 75-85 μm longa et inferne parte crassissima 18-21 μm , rostrum hyalinum aseptatum cum apice pileo gelatinoso subgloboso, hyalino praedita, 2.6-3 μm crassa.

In ramiis emortuis, río Santiago, Buenos Aires, holotypus LPS 44135.

Mycelium immersed. Conidiophores macronematous, mononematous, solitary, straight, simple, septate, with smooth walls, brown up to 160 μm long and 6-8 μm thick (8-10 μm at the base). Conidiogenous cells polytretic, integrated, sympodial with dark scars. Conidia solitary, dry, acrogenous obclavate, transversely 5-8 septate, with a large dark scar at the base, smooth, with the basal and top cells hyaline, brown to dark brown, 75-85 μm long and 18-21 μm in the wider part, beak hyaline, aseptate with a gelatinous cup subglobosa, 2.6-3 μm .

Our microorganisms could be included in the genus Phaeotrichoconis as modified by Ellis (1971) but differs from the other species of the genus [P. crotalarie (Salam et Rao) Subramanian; P. urariae Bharadway and P. aurata Rambelli] in several characters such as: the jelly cup of the beak, the dark scars of the conidiogenous cells, and mainly in the dimensions; for this reason we propose for our strain the name P. minigelatinosum as a new species.

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THE ANAMORPH OF STEPHENSIA BOMBYCINA

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ABSTRACT

Conidial growth was observed in the culture of a strain of *Stephensia bombycina* isolated from the gleba of a sporocarp (Fontana and Giovannetti, 1980-81). Conidiophores developed in groups, forming soft tufts in the proliferating mycelium. The single conidiophores consisted of repeatedly branching hyphae. Branching was mostly dichotomous with lateral branches at various angles, though often at nearly-right angles. Conidiophore septate hyphae had finely verruculose walls. The apices of their terminal branches formed single conidia as well as groups of 2 or 3 (or more?). Conidia varied in shape and size though most were spherical, ellipsoidal or with a truncated base; their walls were covered with warts. Conidiogenesis was blastic, apparently by more than one possible development process. Solitary holoblastic conidia may be produced by determinate conidiogenous cells and botryous holoblastic conidia, by determinate conidiogenous cells, perhaps asynchronous, or by sympodially proliferating conidiogenous cells. *Stephensia bombycina* conidia closely resemble those observed by Uecker in 1967 in *S. shanori*. Conidiophore branching appears to be more complex in *S. bombycina*. In conclusion, *Stephensia* is the only genus of the *Tuberales* so far found to have an anamorph.

Key word: *Stephensia bombycina*, anamorphic state, conidiogenesis.

We have described micro- and macro-characteristics of *Stephensia bombycina* (Vitt.) Tul. et Tul. grown in pure culture (Fontana and Giovannetti, 1980-81). We had not yet observed conidia on isolates until January 1983, when conidiophores and conidia appeared in one isolate. The anamorphic phase seems to be rare event in *Tuberales* and had so far only been observed in *Stephensia shanori* (Gilkey) Gilkey (Uecker, 1967); thus we thought it interesting to report the presence of anamorph in *Stephensia bombycina*.

Our aim is to describe the characteristics of conidiophores grown in a culture a considerable time after it had been isolated from the gleba of a sporocarp and then transferred several times on malt agar substrates.

MATERIAL AND METHODS

The *Stephensia bombycina* strain classified as CMT 300.79 was observed; this isolate has been sent to C.B.S. in Baarn, Holland. It was obtained from fragments of a young sporocarp on malt agar (Fontana and Giovannetti, 1980-81). The same medium was used during the subsequent transfers in culture tubes. Room temperature (16-28°C depending on season) and light were used.

Samples from the tube colonies of both conidia and conidiophores were prepared for light microscopy (LM) and scanning electron microscopy (SEM). Material for LM was prepared on a slide with water or lactic acid. Samples for SEM were initially fixed with 2.5% gluteraldehyde in a 0.1 M cacodylate buffer and fixed in 1% osmium tetroxide in the same buffer. Subsequently specimens were dried by the critical point method in a DCPI Denton Vacuum. Lastly, they were coated with gold and platinum in a Sputtering Hummer II (Technics) and observed with an Etec Autoscan SEM at 20 KV.

Microcultures on malt agar in a 21°C damp room

were prepared to observe conidia germination with a light microscope.

RESULTS

Conidiophores were observed 5 months after transfer only in a very few of the transferred colonies. When colonies did produce conidia, the conidia lasted for one year. No more have been observed since. The following observations were collected during the short anamorphic phase of *Stephenisia bombycina*.

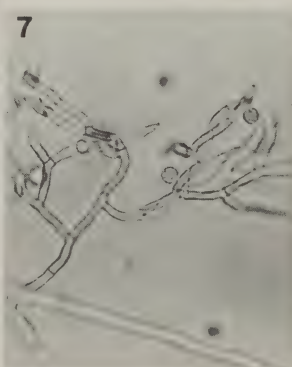
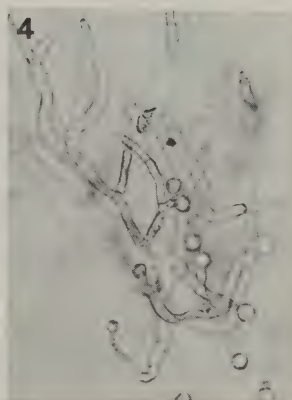
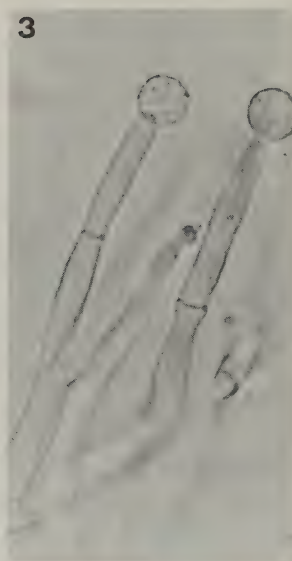
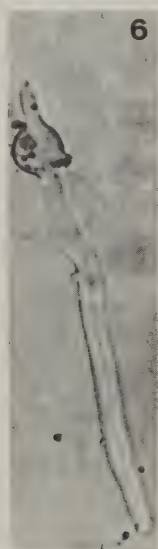
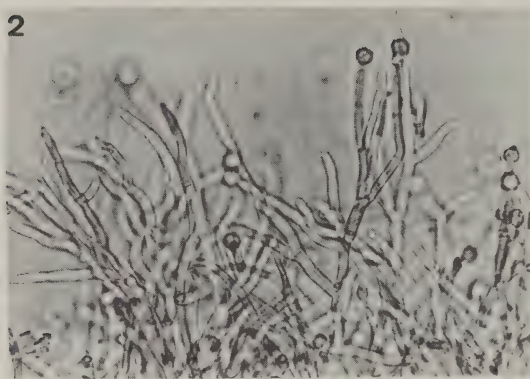
Conidiophores gathered in variably sized, soft tufts, mostly in the upper part of the colonies among proliferating mycelium. They otherwise gathered at the reverse side of the colonies on the agar medium, which becomes a colonizing ground once separated from the glass tube wall. Conidiophore tufts are white at first and then become buff with age.

Each conidiophore consists of a hypha which repeatedly branches out in the course of its growth. Branching is mostly dichotomous with a development of lateral branches at various angles, though quite often at nearly-right ones (Figs. 1, 2, 3, 4 and 7).

Each conidiophore is quite complex and ends up with a tree-like appearance (Fig. 7). When many of them gather together, they produce the tufts visible with a naked eye. Conidiophore hyphae have many warts that can always be seen with SEM (Figs. 8 to 13). Each one is about $4\ \mu$ in diameter (ranging from 3.9 to $5.2\ \mu$), with septa always present at branchings (Figs. 1, 4 and 7).

Conidia develop at the end of the terminal branches either alone or in groups of 2, 3 - or more? (Figs. 8 to 12). SEM observation of conidiogenous cells apices shows one or more scars caused by conidial detachment (Fig. 11).

The color of young conidia ranges from hyaline to straw-yellow. They have warts or spines up to



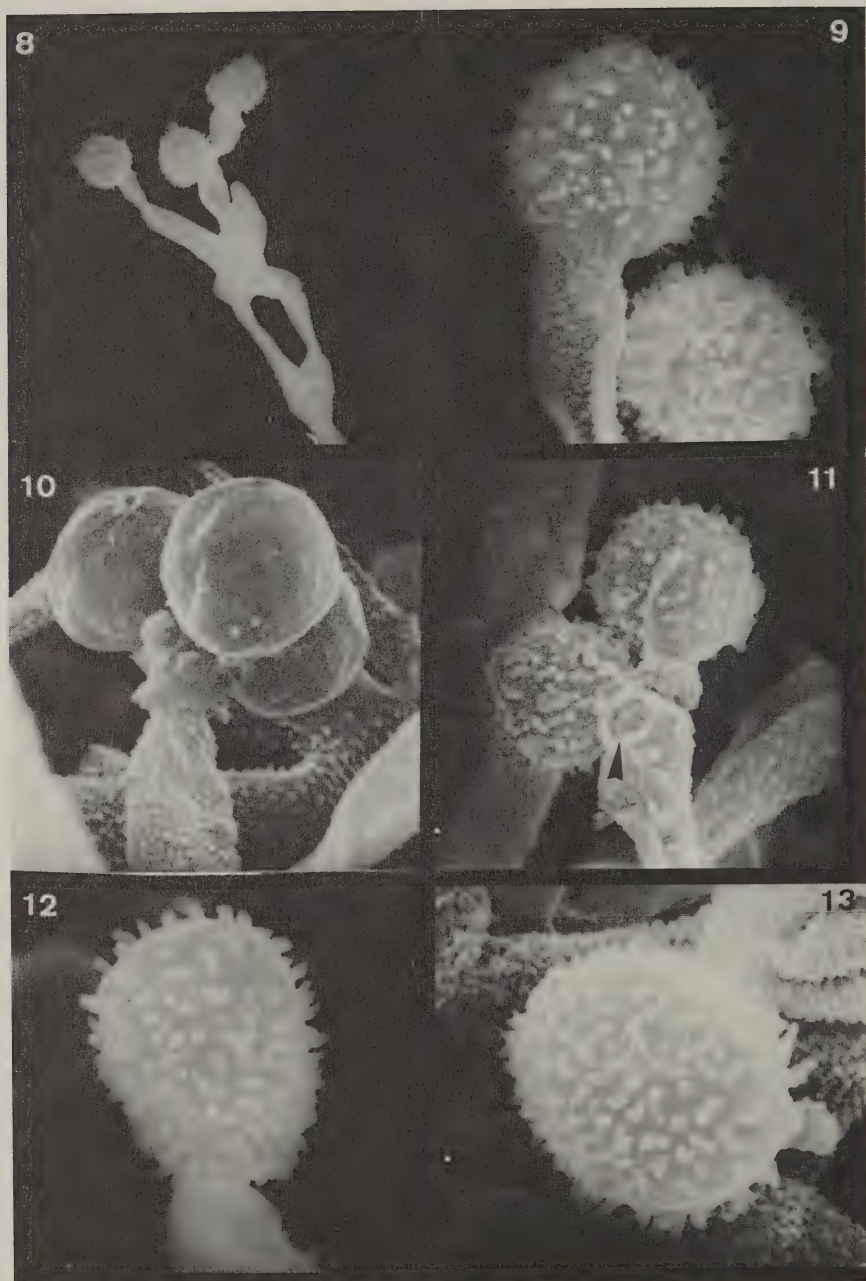
1.3 μ long. Mature conidia are buff with thickened walls and are also very verruculose (Figs. 2,5,8,9,11,12 and 13).

Conidia are spherical or ellipsoidal with a truncated base or a small peduncle - which may be the residue of the conidiogenous cell (Fig. 13) - or a truncated base with a pointed apex. Conidial diameters range from 6.5 to 8 μ in the spherical ones and from 7.8x5.8 μ to 9.7x6.5 μ in the ellipsoidal ones and in those with a truncated base.

Light microscopy and SEM suggest conidiogenesis is blastic with more than one mode of formation. Light microscopy and SEM have shown solitary holoblastic conidia which are likely to be botryous and which could be an asynchronous product of determinate conidiogenous cells, as in *Nodulisporium griseo-brunneum* (Cole and Samson, 1979). They could also be the product of sympodial proliferating conidiogenous cells as in *Sporothrix*, *Fonsecaea*, *Calcarisporium* (Cole and Samson, 1979; Cole, 1981). In *Stephensia* it is not easy to establish whether conidiogenous cells were determinate or proliferating in a sympodially reduced manner. Further studies, above all transmission electron microscope (TEM), will enable us to better understand conidia formation.

Microcultures made it possible for us to observe conidia germination. They often produce only one germ tube 4-5 days after the microculture has been prepared - though at times two developing in opposite points of the conidium have been observed (Figs. 5 and 6).

Stephensia bombycina. Figs. 1, 2. Conidiophores in malt agar culture, x 250 and x 300. Fig. 3. Terminal conidiophore branches with conidia, x 690. Figs. 4,7. Single conidiophores with dichotomic branchings, x 250. Fig. 5. Conidium with germ tube, x 650. Fig. 6. Conidium with two germ tubes, x 650.



DISCUSSION

Many *Ascomycetes* have anamorphs (Alexopoulos and Mims, 1979). However, such a phase appears to be rare in *Tuberales*. This may be because these fungi are not easily grown *in vitro*: if they do have a conidial phase in nature it is very difficult to detect and recognize.

Chaze and Mestas (1939) and then Chaze (1950) reported conidia in *Tuber melanosporum* Vitt. Our current knowledge is based on *in vitro* cultures of *Tuber melanosporum* and other *Tuber* spp. (Fontana 1968, 1971; Chevalier, 1972). Chaze and Mestas said they obtained conidia as well as perithecia and asci in rapidly growing, black cultures: we now know their reports were not reliable, as *Tuber melanosporum* mycelium is a slow-growing and is not black.

As mentioned, in 1967 Uecker reported conidia formation in the American species *Stephensia shanori*, both with fragmented sporocarps and ascospores. He did not, however, observe conidia germination.

Anamorphs in the *Tuberales* have so far been observed only in *Stephensia*.

Comparing Uecker's observations on *Stephensia shanori* to the conidia and conidiophores characters we described in *S. bombycina*, one notices the great resemblance between the conidia of the two species in shape, size, wall color, and warty walls. Single or less complex conidiophores in *S. shanori* do not resemble *S. bombycina* ones.

The mycelium De Vries (1985 a and b) recently isolated from young *Stephensia crocea* Qué! ascocarp

SEM *Stephensia bombycina*. Fig. 8. Terminal branches of conidiophores with conidia, x 1150. Figs. 9-12. Single conidia (Fig. 9, x 4050 and Fig. 12, x 4850) and in groups of 2-3 at the conidiogenous cell apices (Figs. 10 and 11, x 3350). Notice the scar produced by the conidium having fallen off (arrow). Fig. 13. Conidium with peduncle, x 4700.

has not yet produced conidia. It is the first time one of the species has been observed in Holland; considering ascocarp and ascospore characters *S. crocea* appears to be a synonym of *S. shanori*.

We found no indications in the literature on Hyphomycetes that might be responsible for the *S. bombycina* anamorph. TEM studies may reveal conidiogenesis development in more detail.

ACKNOWLEDGMENTS

We thank Dr. Anna Maria Luppi Mosca and Dr. James M. Trappe for critical review of the manuscript.

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NOTES ON CLAVARIOID FUNGI. XXI. NEW ZEALAND TAXA OF TREMELLODENDROPSIS

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Abstract

Prior taxonomic treatments of Tremellodendropsis are reviewed, keys and descriptions of New Zealand representatives of the genus are furnished.

Introduction

Corner (1950) proposed the genus Aphelaria, and later (Corner, 1966) gave the diagnostic separating characters as "... flattened branching, white nonamyloid spores, and tough consistency caused by the narrow, compact, and uninflated hyphae with slightly thickened walls." Assumed but not stated was the production of holobasidia, which separated Aphelaria from Tremellodendron (crucially septate basidia) and from Paraphelaria (transversely septate basidia). Among the taxa placed in Aphelaria were some in which the basidia became incompletely crucially septate by the formation at the basidial apex of three longitudinal septa ending without attachment to the basidial wall or to a transverse septum. Also included were taxa with clamped and unclamped septa. The type species of Aphelaria, A. dendroides (Jungh.) Corner, showed normal holobasidia and unclamped hyphae (Corner, 1966).

Corner (1953) judged that three distinct groups could be defined within Aphelaria, as follows: 1) clampless, with aseptate basidia; 2) clamped, with incompletely crucially septate basidia; and 3) taxa with gloeocystidial elements (all collections of this groups were sterile, and no formal nomenclatural designation was made). Group 1 included the type species of the genus, A. dendroides, and so was named subg. Aphelaria. Group 2 was typified by A. tuberosa (Grev.) Corner, and was named subg. Tremellodendropsis.

Corner (1953, 1966) explained the incomplete basidial septa by stating that the basidial apex was "...sulcate from the sinking of the sterigmatal bases" Crawford (1954) added another category when she reported on some collections in which basidia were completely cruciately septate. That is, the longitudinal basidial septa either joined the basidial wall or joined a transverse septum across the basidium. The result was a basidium in which the lower portion was separated from the upper, and the latter divided into four cells. Crawford (1954) perceived two distinct genera in this complex: Aphelaria (clampless, holobasidial) and Tremellodendropsis (clamped, with basidial septation - an elevation of Corner's subgenus). Tremellodendropsis [typified by T. tuberosa (Grev.) Crawford] was divided into two subgenera, Tremellodendropsis (incompletely septate basidia) and Transeptia (completely septate basidia, typified by T. transpusio Cawf.).

Reid (1956) considered T. transpusio, T. pusio, and T. flagelliformis all to be synonymous, judging that all produced tremellaceous (completely cruciately septate) basidia and that spore differences were minor. Nonetheless, all differed from Tremellodendron by presence of clamps and hyphae with thinner walls. For this group, equated with Crawford's Tremellodendropsis subg. Transeptia, he proposed a new genus, Pseudotremellodendron Reid. Tremellodendropsis was thus rendered monotypic, with only T. tuberosa (incompletely septate basidia).

Corner (1966) examined material of all described taxa in these genera, returning to Crawford's taxonomy of Aphelaria and Tremellodendropsis. He suggested that Transeptia might warrant a separate genus. He also commented that a transverse basidial septum was often formed in T. tuberosa, homologous to that in taxa which Reid (1956) had placed in Pseudotremellodendron.

Dogma (1966) repeated Corner's (1953) taxonomy, but did not cite later literature, and proposed no new taxa. Finally, Corner (1970) again repeated Crawford's (1954) generic and subgeneric taxonomy.

Interestingly, although basidia in Aphelaria and Tremellodendropsis subg. Tremellodendropsis were considered as holobasidia by Corner (1966), these genera were not mentioned in a spate over the classification of taxa with septate holobasidia (Lowy, 1968, 1969; Talbot, 1968).

Recent field collecting in New Zealand and accumulated type specimen studies (Petersen, 1985) present an opportunity to assess Tremellodendropsis taxa from that country, and thereby to furnish new evidence for the efficacy of the genus.

Materials and Methods

Study of herbarium material is hampered by the tough consistency of fruitbodies. Soaking for several minutes in 2% KOH softens the tissue somewhat, at which time it can be teased apart using sharp metal needles. Even then, cover slips are often broken when squash mounts are attempted.

Basidial morphology is best seen in 2% KOH + 1% phloxine, with the phloxine replaced by more KOH. Spore and basidial measurements have been made in 2% KOH and phase contrast microscopy. For most names I have examined type specimens (indicated in the citation by [!]). Redescriptions of these type specimens have been part of a separate paper (Petersen, 1985). Color names in quotation marks are from Ridgway (1912), and herbarium abbreviations are from Holmgren et al. (1981). Other abbreviations are as follows: ATNP = Abel Tasman National Park; UNP = Urewera National Park; WKR = Waipoua Kauri Sanctuary; $\underline{E}$ = spore length divided by width; $\underline{E}^m$ = mean $\underline{E}$; $\underline{L}^m$ = mean spore length; FCL = 10% aqueous ferric chloride.

Key to the New Zealand species of Tremellodendropsis

1. Basidia incompletely cruciately septate; spores
subglobose to broadly ellipsoid to ellipsoid 2
1. Basidia completely cruciately septate; spores
ellipsoid ($\underline{E}^m = >1.6$) 3

2. Spores 10-12 X 7.2-8.6 μm ($\underline{L}^m = 10.6 \mu\text{m}$);
fruitbodies pallid pinkish tan;
odor negligible T. flagelliformis
2. Spores 8.3-9.4 X 6.8-7.6 μm ($\underline{L}^m = 8.9 \mu\text{m}$);
fruitbodies pale dull yellow (cream color);
odor mild to moderate, spicy . Tremellodendropsis sp. I
2. Spores 11.5-15.1 X 6.5-7.9 ($\underline{L}^m = 12.89 \mu\text{m}$);
fruitbodies color probably creamy; odor unknown;
Australia T. lurida
3. Spores not germinating by repetition; basidia
subbulbous, often aberrantly septate T. inflata
3. Spores germinating by repetition; basidia
subbulbous or not 4
4. Basidia subcylindrical to clavate, never bulbous;
fruitbodies upright, slender T. pusio
4. Basidia subbulbous when young; fruitbodies
positively geotropic, on soil overhangs
with algae Tremellodendropsis sp. II

Taxonomic treatment

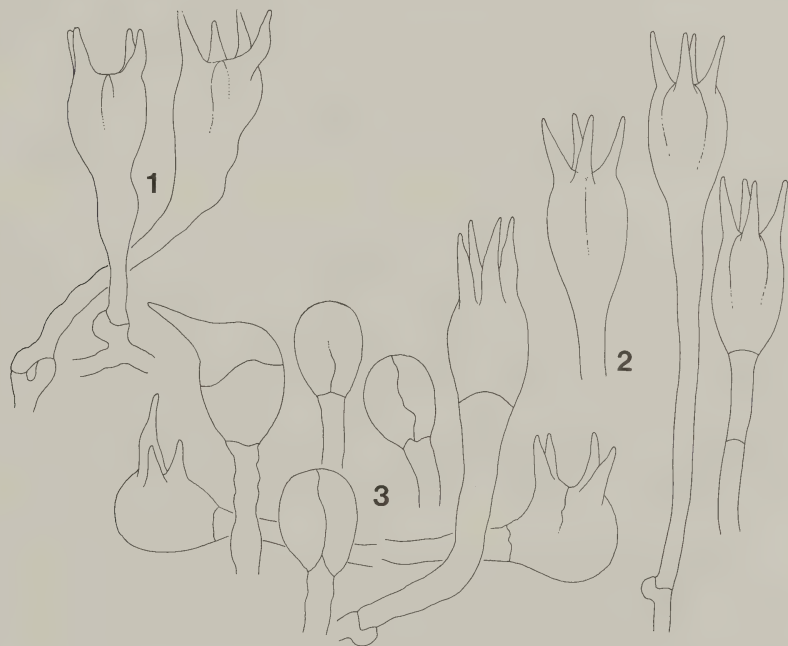
- Tremellodendropsis flagelliformis (Berk.) Crawford. 1954.
Trans. Roy. Soc. New Zealand 82: 621. [Fig. 1]
- $\equiv$ Clavaria flagelliformis Berkeley in Hooker. 1867.
Flora New Zealand, p. 186. [!].
- $\equiv$ Lachnocladium flagelliforme (Berk.) Cooke. 1892. Hand-
book Aust. Fungi, p. 179.
- $\equiv$ Aphelaria flagelliformis (Berk.) Corner. 1953. Ann. Bot.,
n.s. 17: 350.
- = Pterula tasmanica Lloyd. 1923. Mycol. Notes 70: 1227, fig.
2539. [!]

=Aphelaria tasmanica (Lloyd) Corner. 1950. Ann. Bot. Mem. 1: 191.

=Tremellodendropsis flagelliformis var. tasmanica (Lloyd) Crawford. 1954. Trans. Roy. Soc. New Zealand 82: 623.

=Tremellodendropsis flagelliformis var. ovalispora Crawford. 1954. Trans. Roy. Soc. New Zealand 82: 621 [!] [Fig. 2]

Fruitbodies up to 6 cm high, up to 2.5 cm broad, arbuscular, erect, branches in 2-4 ranks. Stipe arising from spreading white, tough, basal patch or a tight ball of mycelium involving significant substrate, usually discrete, up to 30 X 4 mm, off-white to "pinkish buff," felty but not



Figs. 1-3. Basidia of Tremellodendropsis species. 1. T. flagelliformis, NY, Cuba. 2. T. flagelliformis var. ovalispora, type specimen. 3. T. inflata, TENN 42468. Figures not to scale.

strigose. Branches erect, tough, somewhat divergent, flattened below, less so upward, "cinnamon buff," "vinaceous buff," "light ochraceous buff," "pinkish buff," "avellaneous;" axils acute; apices prolonged, terete, off-white ("pale pinkish cinnamon"); all parts occasionally rubri-vinescent upon bruising ("dull Indian purple," "anthracene purple"). Taste negligible to musty; odor negligible. FCL = negative to grey.

Hyphae of branch trama 2-4 μm diam, thin- to slightly thick-walled (wall up to 0.3 μm thick), strictly parallel, tightly packed, hyaline, clamped. Hymenium thickening; basidia 90-130 X 10-12 μm , with a long equal base, broadly clavate upward, aseptate to incompletely cruciately septate, the septa extending to 20 μm and ending indiscretely; contents multiguttulate to granular when immature, coalescing into several large, refringent guttulae by maturity; sterigmata (2)-4, stout, curved, up to 15 μm long. Spores 10-12.2 X 7.2-8.6 μm ($\bar{E} = 1.22-1.48$; $\bar{E}^m = 1.35$; $\bar{L}^m = 10.62$ μm), broadly ellipsoid, smooth, hyaline; contents granular to foamy when immature, uni- to biguttulate when mature, the guttules conspicuously refringent; wall up to 1 μm thick; hilar appendix small, papillate; germination by repetition absent.

Commentary: Even in older portions of the hymenium basidia seem rather uniformly geniculate, with a long equal basal portion distal to a prominent clamp, the apical portion inflating gradually but broadly. The basal portion shows rather homogeneous contents, the apical portion invariably foamy or granular in content under phase contrast, often with a few large, refringent guttules low in the distal portion. Sterigmata are stout from their inception, and elongate significantly to their eventual sublyriform shape.

Most interesting is the incomplete longitudinal septation of the basidial apex. Corner (1953) expanded on Crawford's (1954) description, in which the longitudinal septa were measured as 0-15 μm long, but used the words "... the apex becoming cruciately subsulcate..." and offered illustrations in which discrete longitudinal septa were not clear. Moreover, both Crawford and Corner described older basidia

as sometimes transversely septate after spore discharge

The basidia of the specimens cited below almost always exhibit longitudinal septa by maturity, but these septa end blindly, and usually dissipate into less organized "curtains" before light microscopy fails to resolve them. In no instance have I seen a transverse septum joining the longitudinal ones, although rarely one of the longitudinal septa seems to reach the side of the basidium. In other occasional basidia a discrete transverse septum is formed before spore discharge as described by Corner (1950), much as in Clavulina, but in such basidia there is no evidence of longitudinal septa, or they are short and rudimentary.

Reid (1956) indicated that the type of T. flagelliformis did not support accurate observation of basidial septation. My examination of the type revealed incompletely septate basidia and spores as in Table I.

TABLE I
Spore data on Tremellodendropsis flagelliformis

Label name	Specimen ^a	Mean dimensions (μm)	<u>E^m</u>
<u>T. flagelliformis</u>	TENN 43623 (N.Z.)	8.9 X 7.2	1.23
<u>T. flagelliformis</u>	TENN 42298 (N.Z.)	11.1 X 7.9	1.35
<u>T. flagelliformis</u> var. <u>ovalispora</u>	Crawford 114a (N.Z.)	8.8 X 6.5	1.35
<u>T. flagelliformis</u>	TENN 43622 (N.Z.)	10.3 X 7.8	1.37
<u>T. flagelliformis</u> var. <u>ovalispora</u>	Type (N.Z.)	9.0 X 6.0	1.50
<u>T. flagelliformis</u>	NY 5572 (Cuba)	10.7 X 7.0	1.53
<u>T. flagelliformis</u>	Type (N.Z.)	10.5 X 6.3	1.56
<u>Pterula tasmanica</u>	Type (Tasmania)	11.1 X 6.7	1.70

^a For more information, see Specimens Examined in text.

Within T. flagelliformis Crawford (1954) proposed three varieties, based on spore dimensions and E^m values. From my own collections I conclude that as in T. pusio spores are

variable in T. flagelliformis, and that varietal epithets have only limited use.

Crawford figured several spores from each of five specimens of T. flagelliformis, showing only one spore with a projection which Reid (1956) interpreted as germination by repetition. He did not report on the phenomenon from the type specimen. I have seen none in all the specimens I have seen, and I conclude that the character is absent.

The key to Crawford's (1954: 623) separation of var. ovalispora was the following: "spores 7.5-12(-13) X 6-9 μ m, shorter than var. tasmanica and broader than T. flagelliformis ..." Two factors complicate this analysis: 1) the type specimens of Clavaria flagelliformis and Pterula tasmanica are (and presumably were for Crawford) poorly dried and most spores are in some state of collapse; and 2) spore measurements must be obtained from hymenial squashes. The latter would seem routine, but with some variation in number of spores per basidium, a concomitant variation in spore dimensions must be expected. Moreover, I have (and must assume the same of others) a strong tendency to measure turgid spores, rather than estimating dimensions of semicollapsed spores, and in this group, turgidity seems to be unrelated to size. All told, Crawford seemed to separate two taxa on what I consider small differences in spore dimensions. For the reasons above, at least in this group, I find it more practical to lump specimens. Thus, I consider Crawford's var. ovalispora and Pterula tasmanica to be synonyms of T. flagelliformis. Conversely, I agree with Crawford that T. pusio is separate, based on my own analysis of the type specimen.

Crawford did not report on any color changes in fruitbodies, but Corner (1966) suggested some differences as "... pale brownish rufescent or subvinaceous downwards...." Most specimens which I collected showed little or no color change, but no. 42297 exhibited very strong rubri-vinescent staining when handled or pinched on picking, or even where fruitbodies touched in the wrapper after collection. Strangely, no. 43727, collected on the exact same spot one year later showed rather little and weak color change.

In most specimens, the upper branches dry horny and dull orange, while the stipe remains off-white. In some, however, the branches dry yellowish, with no other discernable differences.

Type specimen studies have been reported by Petersen (1985) for C. flagelliformis, P. tasmanica, and T. flagelliformis var. ovalispora.

Specimens examined: North Island: Waitakare Ranges, 27.v.83, coll. RHP, no. 43845 (TENN); Wellington, Quoin Ridge, 8.vii.48. Crawford no. 157 (holotype of var. ovalispora, PDD); Wellington, Keith George Park, no date, Crawford no. 114A (PDD); Urawera National Park, 22.vi.81, coll. RHP, no. 42185 (TENN); WKR, Kauri forest, 22.vi.81, coll. RHP, no. 42293 (TENN); WKR, 23-24.vi.81, nos. 42297, 42298 (TENN); WKR, 30.v.82, coll. RHP, no. 43727 (TENN); WKR, 29.v.82, nos. 43131, 43622 (TENN); UNP, 25.v.82, coll. RHP, no. 43448 (TENN); Bay of Islands, no date, herb. Berkeley, s.n. (holotype of C. flagelliformis, K); Puketū State For., 2.vi.82, no. 43623 (TENN).

South Island: vic. Karamea, Granity Creek Valley, 9.vi.81, coll. RHP, no. 42417 (TENN); ATNP, Coast Track, 16.v.82, coll. G. G. Samuels, no. 43610 (TENN).

AUSTRALIA: Tasmania, no date, Rodway no. 1267, Lloyd no. 32715 (holotype of Pterula tasmanica, BPI).

Tremellodendropsis inflata (Crawford) Petersen,
stat. nov.

[Fig. 3]

Bas. Tremellodendropsis transpusio var. inflata Crawford. 1954. Trans. Roy. Soc. New Zealand 82: 625 [!].

= Tremellodendropsis transpusio var. minor Crawford.
1954. Trans. Roy. Soc. New Zealand 82: 625 [!].

Fruitbodies up to 3 cm high, up to 1.5 cm broad, branched, erect, arising from an off-white basal mat involving a small ball of substrate; consistency tough, fibrous. Stipe up to 20 X 3 mm, off-white to pallid pinkish tan ("pinkish cinnamon," "pinkish buff"), felty, occasionally strigose at very base. Branches concolorous, flattened, erect, parallel to somewhat divergent; axils acute; apices prolonged, <1 mm thick, "pinkish buff" to "pale pinkish cinnamon," more or less terete. No color changes on bruising or picking. Taste negligible; odor negligible to faintly musty. FCL = negative.

Hyphae of branch trama 1.8-2.5 μm diam, thin- to slightly thick-walled (wall up to 0.3 μm thick), hyaline, strictly parallel, tightly packed; septa with or without clamp connections. Hymenium thickening; basidia 40-60 X 9-11 μm , arising as a digitate hyphal tip from a clamp, elongating significantly, then rather abruptly inflating distally, becoming transversely septate about 18-25 μm from the apex, then producing longitudinal septa between the sterigmata which join the transverse septum; mature basidia retaining the subbulbous shape; sterigmata (2)-4, stout, divergent, occasionally arising laterally on the basidium. Spores 9-11.2 X 5.4-6.8 μm ($\underline{E} = 1.47-1.93$; $\underline{E}^{\text{m}} = 1.67$; $\underline{L}^{\text{m}} = 9.7 \mu\text{m}$), ellipsoid to narrowly ovate, flattened adaxially, hyaline; contents uniguttulate when mature; hilar appendix broad, papillate, truncate; germination by repetition absent.

Commentary: I prefer to keep this taxon separate from T. pusio based on descriptions by Crawford (1954) and Reid (1956) and my own analysis of the type specimens. Crawford figured basidia very similar to those described above, noted "several anomalous basidia ... on which only one abortive sterigma was produced," and did not report basidiospore germination by repetition. Her photograph of a fruitbody is quite similar to those described above, much stouter than those described here for T. pusio.

Reid's (1956) report was based partly on examination of three type specimens, representing Clavaria pusio, Clavaria flagelliformis, and Thelephora archeri. He suggested that all three names were synonymous. The first produced completely cruciately septate basidia and germination by repetition. Although he indicated that "Tremellaceous basidia of the kind figured by Crawford (Fig. III, p. 624) for Tremellodendropsis transpusio" were found on all three types, subsequently statements were so equivocal that it is difficult to know just what was meant. In fact, my examination shows only incompletely cruciately septate basidia on the type specimen of C. flagelliformis. Reid also relied on a single figure by Crawford (Text Fig. IC) to attest to germination by repetition in this taxon. Finally, the basidia of Thelephora archeri were shown to resemble those of Tremellodendropsis tuberosa except for one 2-sterigmate

individual which was shown as completely cruciately septate. All in all, I do not find his arguments convincing.

Crawford included the following diagnosis under T. transpusio var. inflata: "Differs from T. transpusio var. transpusio in the smaller pink fruitbody and wider spores do not germinate by repetition, and basidia are relatively abruptly subbulbous. Because I consider these characters sufficient to circumscribe a species epithet, I am obliged to propose the elevation of Crawford's T. transpusio var. inflata to species rank. Inflata apparently refers to the somewhat broader spores of this species as compared to those of T. transpusio.

Moreover, Crawford stated the following diagnosis for var. minor: "Differs from T. transpusio var. transpusio in pinkish colour of fresh fruit body, and in the shorter spores." My measurement of spores of the type specimen of var. minor are almost the same as those of the type of var. inflata. Both were described as producing pinkish fruitbodies, and the spores of neither germinate by repetition. Unfortunately, the hymenium of the type specimen of var. minor will no longer support accurate examination, but with all other observable characters considered, I conclude that these two varietal names are synonyms. I treat them here under T. inflata.

Specimen no. 42620 (TENN) produced spores shorter and wider than any taxon described by Crawford. My measurements are $8.6\text{--}11.2 \times 5.0\text{--}8.3 \mu\text{m}$ ($\underline{E} = 1.26\text{--}1.82$; $\underline{E}^m = 1.58$; $\underline{L}^m = 9.53 \mu\text{m}$). Nonetheless, basidia conform completely to my description above, and no germination by repetition was seen.

If one follows Crawford's philosophy, spore dimensions and $\underline{E}^m$ values at the high and low ends of the spore statistics on Table II might dictate segregation of two additional infraspecific taxa, especially in light of the presumed geographic isolation of the specimens from the United States. I cannot dismiss, however, that were sufficient material examined, a cline would be revealed, and that it might be impossible to identify separable groups. I have chosen this option and included all the specimens without germination by repetition under one name.

TABLE II
Spore data for Tremellodendropsis inflata

Label name	Specimen ^a	Mean dimensions (μ m)	$\bar{E}^m$
<u>T. inflata</u>	TENN 43620 (N.Z.)	9.5 X 6.3	1.58
<u>T. inflata</u>	TENN 43621 (N.Z.)	9.6 X 5.9	1.64
<u>T. inflata</u>	TENN 37654 (U.S.)	11.4 X 6.6	1.65
<u>T. flagelliformis</u>			
var. <u>inflata</u>	Type (N.Z.)	11.8 X 7.1	1.66
<u>T. pusio</u>	TENN 36971 (India)	10.4 X 6.1	1.69
<u>T. inflata</u>	TENN 42468 (N.Z.)	10.2 X 5.9	1.70
<u>T. flagelliformis</u>			
var. <u>minor</u>	Type (N.Z.)	9.8 X 5.3	1.85
<u>T. flagelliformis</u>			
var. <u>minor</u>	Crawford 258 (N.Z.)	10.6 X 5.1	2.07
<u>T. inflata</u>	TENN 43625 (U.S.)	13.5 X 6.0	2.31
<u>T. inflata</u>	TENN 31364 (U.S.)	11.8 X 5.1	2.32
<u>T. inflata</u>	TENN 33692 (U.S.)	14.3 X 5.0	2.89

^a For more information, see Specimens Examined in text.

It might be added that in most respects, the United States specimens match Tremellodendropsis semivestitum, but that species exhibits incompletely cruciately septate basidia.

I have compared the New Zealand specimens of Tremellodendropsis identified (by me) as T. inflata with specimens from northern India under the name T. pusio (PAN nos. 212, 213, 214, all in TENN under nos. 36970, 36971, 36960, respectively). The Indian specimens did not revive well, but occasional basidia were observed as completely cruciately septate; young basidia were subbulbous, spores were 9.7-11.5 X 5.4-6.8 μ m ($\bar{E}$ = 1.50-2.00; $\bar{E}^m$ = 1.69; $\bar{L}^m$ = 10.40 μ m), and no sign of germination by repetition was seen. In short, the specimens were indistinguishable from the New Zealand taxon.

Specimens examined: New Zealand: North Island: Auckland, Waitakare Ranges, 26.v.65, coll. Dingley, McNabb no. 35 (PDD); Wellington, Keith George Pk., vi.49, Crawford no. 241 (type of T. transpusio var. minor); vic. Levin, no date, Crawford no. 258 (PDD); WKR start of Kaori Ricker track, 31.v.82, coll. RHP, no. 42621 (TENN); Omahutta Forest Sanctuary, Lake Loop Track, 1.vi.82, coll. RHP, no. 43620 (TENN).

South Island: vic. Karamea, Granity Creek Valley, 9.vi.81, coll. RHP, no. 42468 (TENN); Nelson, Rai Valley, no date, Crawford no. 322 (holotype of T. transpusio var. inflata, PDD).

UNITED STATES: Tennessee; Great Smoky Mts. Nat. Park, 3.x.82, no. 43625 (TENN); Same location, Mt. LeConte, viii.64, no. 31364 (TENN); same location, 12.viii.68, no. 33692 (TENN).

Tremellodendropsis pusio Berkeley in Hooker. 1867. Flora of New Zealand, p. 185 [!]. [Figs. 4-6]

=Pterula pusio (Berk.) Bresadola et Sydow. 1914.
Philippine J. Sci., Bot. 9: 352.

=Tremellodendropsis transpusio var. transpusio Crawford.
1954. Trans. Roy. Soc. New Zealand 82: 624 [!].

Fruitbodies up to 2.5 X 1.5 cm, subsimple to branched dichotomously, extremely slender (no part more than 1 mm thick), arising from a small off-white mycelial patch involving very little substrate. Stipe up to 11 X 1 mm, smooth. Branches extremely slender, erect, divergent; axils acute; apices prolonged up to 5 mm, acerose. All parts "pale pinkish buff," with stipe and lower branches bruising dull avellaneous. Taste, odor and FCL reaction unrecorded.

Hyphae of branch trama 1.5-2.5 μm diam, hyaline, thin- to slightly thick-walled (wall up to 0.2 μm thick), strictly parallel, tightly packed, clamped commonly (not invariably). Hymenium thickening; basidia 35-50 X 9-11 μm , clavate, arising as a broadly cylindrical hyphal tip, gradually inflating apically, producing a transverse septum 13-20 μm from the apex, and longitudinal septa between the sterigmata joining the transverse septum and often stretching it upward with apical expansion; contents multiguttulate at maturity; sterigmata 4, stout, somewhat divergent. Spores 9.4-12.2 (15.1) X 5-6 (7.6) μm ($E = 1.80-2.00$; $E^m = 1.87$; $L^m = 10.26 \mu\text{m}$, excluding outsize spore), ellipsoid, flattened adaxially; contents uni- to biguttulate at maturity; hilar appendix blunt, broad; germination by repetition abundant, with the sterigma often double.

Commentary: Far from lumping several names in synonymy (Reid, 1956), I am led to separate these collections from T. transpusio on what may appear to be meager grounds: 1) fruitbodies are much slenderer; 2) they exhibit a color change on bruising; 3) basidia are not subbulbous at any stage of ontogeny; and 4) spores very commonly germinate by repetition. All three collections agree with the type specimen of T. pusio.

Reid (1956), interpreting the basidia of T. pusio as tremellaceous (completely cruciately septate), had to decide whether to place the species in Tremellodendron, a genus with very similar fruitbodies, but with truly tremellaceous basidia (completely cruciately septate, subglobose to broadly ellipsoid when immature) and clampless hyphae. Reasoning from observations on other genera (Eichleriella Burt, Sebacina Tulasne), Reid concluded that basidial profile and shape were not significant, but that absence of clamps constituted a generic character, requiring a new genus name for those whose hyphae were clamped. He proposed the name Pseudotremellodendron.

All the authors cited above have considered the basidia of T. pusio as clavate, and therefore different from those of, say, Tremella. I find that in T. pusio (see above for my sense of that epithet) basidia begin as rather thick (56 μ m diam) hyphal tips, but expand rather abruptly distally, so that the tips are elliptical when the transverse septum divides the apical swelling from the "stalk." The apex then elongates somewhat as sterigmata form, so that the elliptical end becomes less abrupt. In short, basidial ontogeny in T. pusio shows that basidial differences between it and more typical tremellaceous basidia are of degree rather than absolute. One character overlooked in the proposal of Pseudotremellodendron was germination by repetition. Reid was correct; the basidia of the T. pusio group are cruciately septate, but in recent years germination by repetition has assumed increasingly greater importance in the delineation of the Heterobasidiomycetidae (at whatever rank it is assigned). As pointed out above, specimens of T. pusio show the phenomenon, while those of T. inflata do not.

The peculiar double sterigmata produced by many basidiospores may indicate repetitive secondary spore production.

As shown on Table III, spore dimensions vary considerably, and based on this character alone, T. transpusio could be separated from T. pusio. But again I loath to accept this until much additional material has been examined.

TABLE III
Spore data for Tremellodendropsis pusio

Label name	Specimen ^a	Mean dimensions (μm)	$\bar{E}^m$
<u>Clavaria pusio</u>	Type (N.Z.)	13.2 X 7.1	1.82
<u>Clavaria pusio</u>	TENN 42305 (N.Z.)	10.3 X 5.5	1.87
<u>T. transpusio</u>			
var. <u>transpusio</u>	Type (N.Z.)	13.1 X 5.4	2.40
<u>T. transpusio</u>			
var. <u>transpusio</u>	Crawford 310 (N.Z.)	13.4 X 5.5	2.40

^a For more information, see Specimens Examined in text.

Type specimen studies have been reported by Petersen (1985) for C. pusio and T. transpusio.

Specimens examined: North Island: UNP, Black Beech Track, 23.v.81, coll. RHP, no. 42305 (TENN); Wellington, Keith George Park, 10.vi.49, Crawford no. 242 (holotype of T. transpusio - PDD); location unknown, no date, herb. Berkeley, s.n. (holotype of T. pusio - K).

South Island: Nelson, Maitai Valley, no date, Crawford no. 310 (PDD).

Tremellodendropsis species I.

[Fig. 7]

Fruitbodies up to 6 X 2 cm, arising from substantial off-white mycelial patches not involving significant substrate when picked, branched in 2-4 ranks, tough. Stipe up to 33 X 3 mm, off-white, felted, undulate-equal. Branches "cream color" to "warm buff," flattened somewhat downward, more or less terete upward, tough, erect and somewhat divergent; axils acute; apices prolonged, acute, "cream buff." Odor spicy, penetrating, like Clavicornia spp.; taste negligible.

Hyphae of branch trama 2-4 μm diam, thin- to slightly thick-walled (wall up to 0.3 μm thick), hyaline, tightly

packed, strictly parallel, long-celled; septa sometimes clamped. Basidia 80-100 X 10-12 μm , clamped, with long, equal basal portion and abruptly inflated clavate apex, incompletely cruciately septate, the septa extending 6-10 μm in basidial lumen and ending indecisively; contents foamy to multiguttulate; sterigmata 2-4, stout, curved. Spores 8.3-9.4 X 6.8-7.6 μm ($\underline{E}$ = 1.15-1.37; $\underline{E}^{\text{m}}$ = 1.23; $\underline{L}^{\text{m}}$ = 8.9 μm), subglobose to broadly ellipsoid, hyaline; contents uniguttulate when mature; wall up to 0.2 μm thick; hilar appendix papillate, broad; germination by repetition absent.

Observations: The following characters separate this from T. flagelliformis: 1) subtle color differences from the pinkish tan of the latter to pale dull yellow shades; 2) discernable odor of fruitbodies; and 3) somewhat smaller spores with lower $\underline{E}\text{m}$ value. An additional character of dubious value: tissue soaked in 2% KOH was easily teased apart - much more so than any specimens of T. flagelliformis. This may reflect some difference in construction or may be coincidental.

Specimen examined: North Island: Puketū State Forest, vic. Headquarters, on dead tree fern stump, 2.vi.82, coll. G. Samuels, no. 43623 (TENN).

Tremellodendropsis species II.

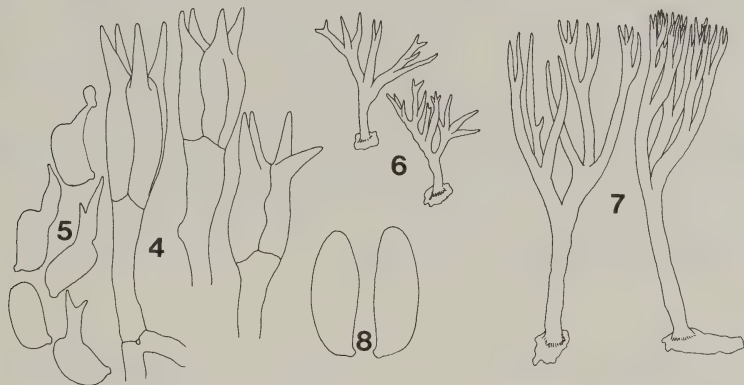
[Fig. 8].

Fruitbodies positively geotropic, up to 7 X 2.5 mm, simple or once-furcate or irregularly lobed, tough in consistency, ivory colored to very pale clear yellow, tapering toward base, flattened toward apex and often narrowly palmate, arising from inconspicuous mass of mycelium and involving significant soil when picked; apex often "avellaneous;" on volcanic soil covered with algae.

Trametal hyphae 3-4 μm diam, thin- to thick-walled (wall up to 0.3 μm thick), hyaline, conspicuously clamped, loosely packed, generally parallel. Subhymenium rudimentary. Hymenium thickening, with effete basidia crumpled but persistent; basidia 65-75 X 17-21 μm , inflated apically but with equal basal portion, completely cruciately septate, clamped; contents multiguttulate to foamy upward, with proximal portion becoming homogeneous; sterigmata 4, up to 11 μm long, stout, straight, divergent. Spores 13.7-17.6 X 6.8-7.9 μm ($\underline{E}$ = 1.86-2.29; $\underline{E}^{\text{m}}$ = 2.14; $\underline{L}^{\text{m}}$ = 15.9 μm), boletoid to undulate-cylindrical, hyaline, smooth, thin-walled; contents opales-

cent; hilar appendix inconspicuous, papillate; germination by repetition occasional.

Commentary: This taxon is known from only one collection, made on a soil bank along the road from the plateau to



Figs. 4-7. *Tremellodendropsis* species. 4-6. *T. pusio*, TENN 42305. 4. Spores, showing germination by repetition. 5. Basidia. 6. Fruitbodies. 7. *Tremellodendropsis* species I, fruitbodies. 8. *Tremellodendropsis* species II, spores. Figures not to scale.

the motel on the north slopes of Mt. Egmont. There it seemed to fruit only along a narrow black stratum, and always associated with a blue-green alga. In this way it is like *Multiclavula*, the New Zealand species of which have been described elsewhere (Petersen, 1987). Moreover, all fruitbodies were positively geotropic or (rarely) ageotropic, although the incline of the soil would easily permit a negatively geotropic habit.

The transverse septum of the young basidium is apparently developed first, with the longitudinal septa forming later and eventually joining the transverse septum. After this union, the basidium seems to elongate slightly, which causes the transverse septum to become stretched in a distal direction. Basidial inflation takes place after or simultaneously with septum formation, for young basidia are not significantly inflated. The basal portion remains more or less equal, with only the apical 25-30 μm swelling. Often basidia are observed with one or more apical cells empty,

but with one or more turgid cells remaining. The basal portion (equating with Crawford's concept of the "stalk-like portion") remains turgid even after the collapse of the apical cells.

Spores of this taxon are far longer than those of any other New Zealand taxon, but are matched by some Northern Hemisphere collections. Spore dimensions have been derived from hymenial squashes, so the L^m value may be rather low and the E^m slightly high. While germination by repetition is not abundant in this collection, several spores with secondary sterigmata were observed. Confusing the situation are contaminant spores (probably Deuteromycetes) with a single tendril or gelatinous process at each end, superficially resembling secondary sterigmata.

With only one collection, I must decline to propose a new name.

Specimen examined: North Island: Mt. Egmont, 24.iv.83, coll. RHP, no. 44417 (TENN).

Discussion

Germination by repetition, so heavily weighted at the order to subclass rank (Heterobasidiomycetes vs. Homobasidiomycetes) has been overlooked or poorly observed at the species or infraspecific rank in this group. Of the material with completely cruciately septate basidia alone, only four specimens show this character. Reid (1956) reported both completely cruciately septate basidia and spore germination by repetition on the type specimen of Clavaria pusio. I have observed no germination by repetition in the thousands of spores scanned from specimens under other names. Crawford neither reported nor figured any. Corner (1966) was dubious about the universality of the phenomenon, retaining Crawford's taxonomy in the face of Reid's report of synonymy.

One must also consider the size and shape of sterigmata. In the Tremellaceae, sterigmata (epibasidia) are indefinite in length - cylindrical tubes which extend until their tips reach the fruitbody (often gelatin) surface. This is so in Tremellodendron. In Tremellodendropsis, however, sterigmata are of definite length, and curved tapered as

typical of the Homobasidiomycetes. To my knowledge, the combination of cruciately septate basidia (either completely or incompletely) and "homobasidial" sterigma morphology is rather uncommon and when basidial shape (clavate, often apically swollen but not sphaeropedunculate), basidiospore germination by repetition and presence of clamp connections are added, the group of taxa is easily separated from Tremellodendron (tremellaceous basidial morphology, no clamp connections). Conversely, this combination of characters (above) ties the group together, making Reid's (1956) Pseudotremellodendron unnecessary and inadvisable. The type species, P. pusio (Tremellodendropsis pusio) can be separated from other similar taxa only by basidiospore germination by repetition. I consider Tremellodendropsis a cohesive group, not requiring cleaving at this time.

Notes on extra-limital taxa

Tremellodendropsis lurida (Kalch.) Petersen, comb. nov.

[Basionym: Clavaria lurida Kalchbrenner. 1882. Proc. Linn. Soc. N.S.W. 7: 107-108.

Isotype: BPI - Australia [Western Port], no date, ex herb Bresadola, "orig! ex reliquiae Kalchbr.," s.n. [!]

Fruitbody one, 2.5 X 1.5 cm, flattened throughout; stipe 4 X 4 mm, minutely matted, flattened, probably cream-colored to tan when fresh, now ochraceous tan; major branches erect, flattened, now fuscous brown, irregular (not dichotomous); axils acute; internodes diminishing gradually; apices flagelliform, sterile in apical 3-4 mm, flattened, cristate. On sandy soil with moss.

Tramal hyphae 1.5-3 μ m diam, thin-walled, hyaline to pale tan, clamped, strictly parallel, now agglutinated. Subhymenium rudimentary. Hymenium apparently thickening, up to 100 μ m thick; basidial length not measurable, width 14-18 μ m; basidium composed of a cylindrical, often geniculate lower portion and inflated, broadly ellipsoid to obovate apical portion, not transversely septate, incompletely cruciately septate; contents indistinctly granular; sterigmata

2-4, stout subcornute. Spores 11.5-15.1 X 6.5-7.9 μm ($\bar{E}$ = 1.60-2.06; $\bar{E}^m$ = 1.86; $\bar{L}^m$ = 12.89 μm), obovate to ellipsoid, flattened adaxially, smooth, thin-walled; contents opalescent-refringent when viable; hilar appendix broad, papillate; germination by repetition absent.

Commentary: Incompletely cruciately septate basidia and lack of germination by repetition lead one to compare the type specimen of C. lurida with Tremellodendropsis flagelliformis. The latter apparently comprises slenderer fruitbodies and smaller spores. I prefer to keep T. lurida separate, therefore, until more Australian material can be examined. A new combination in Tremellodendropsis is required, however.

Additional label data on the isotype specimen are as follows (outer packet is standard USDA issue): Clavaria lurida Kalchbr. = Lachnocladium flagelliforme (Bk.) Cooke. Hyphae 2-4 laevae, pallidae; sporae? amygd[aliform] hyal[inae] 12-15 = 4-6 u. orig! Australia. ex reliquiae Kalchbr.

Tremellodendropsis semivestitum (B. & C.) Petersen, comb. nov.

Bas.: Lachnocladium semivestitum Berkeley & Curtis. 1873.
Grevillea 1: 161 [!]

A type study on this taxon was reported by Petersen (1985). Spores are unusually long for the genus, basidia are incompletely cruciately septate, and no reliable germination by repetition was observed. The taxon seems restricted to eastern North America where it is occasional.

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THREE NEW POWDERY MILDEWS FROM NORTHERN INDIA (ASCOMYCOTINA - ERYSIPTACEAE)

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SUMMARY

During a survey of Garhwal region in the month of October 1984, a large number of powdery mildews were collected and identified. Out of these, three new species of powdery mildews viz., Erysiphe garhwalensis on Urtica dioica L., Microsphaera indica on Rosa webbiana Wall. and Phyllactinia phaseolina on Phaseolus trilobus Ait. were created on the basis of their teleomorphic states. Anamorphs were not observed. The holotype of these fungi are deposited in Herbarium Cryptogamae Indiae Orientalis (H.C.I.O.), Division of Mycology and Plant Pathology, Indian Agricultural Research Institute (I.A.R.I.), New Delhi - 110012, India.

1. Erysiphe garhwalensis Ahmad, Agarwal & Sarbhoy sp. nov.

Coloniae amphigenae; mycelium persistens, gracile et effusum; cleistothecia gregaria vel dispersa, globosa vel depresso-globosa, 80-120 μ m in diam., cellulae parietis 10-24 μ m crassae; appendiculae mycelioidae, hyalinae, numerosae, mycelio aseptato vel 1-2 septato mixto, rare ramosae plus minusve rectae; asci 4-8, globosi ad ovaes vel ellipsoidei, stipite brevi, 45-78 x 35-55 μ m; ascospora 3-5 ovato vel oblonga, 18-27 x 12-17 μ m. (Fig. 1).

In Urtica dioica L., Badrinath, Garhwal, U.P., 20.10. 1984 et Holotypus in H.C.I.O. 35163, I.A.R.I., New Delhi, India.

Colonies amphigenous; mycelium persistent, thin and effused; cleistothecia gregarious or scattered, globose or depressed globose, 80-120 μ m in diam., wall cells 10-24 μ m wide; appendages mycelioid, hyaline, numerous, intermingled with mycelium, aseptate or 1-2 septate, rarely branched more or less straight; asci 4-8 in number, globose

to oval or ellipsoidal with short-stalk, 45-78 x 35-55 μm ; ascospores 3-5, ovate or oblong, 18-27 x 12-17 μm .

The present species can be distinguished from Erysiphe urticae (Wallr.) Blumer in having almost hyaline appendages on relatively smaller cleistothecia. It also differs from the latter in number and size of the asci per cleistothecium and ascospores per ascus.

2. Microsphaera indica Ahmad, Agarwal & Sarbhoy sp. nov.

Coloniae amphigenae; mycelium persistens et effusum; cleistothecia saepe gregaria in fragmenta floccosa vel interdum dispersa, depresso-globosa, 114-171 μm in diam., cellulae parietis 9-18 μm crassae; appendiculae 8-25, 90-180 μm longae, usque ad 9 μm crassae, plus minusve flexuoso-contortae, angulatae flexae et non-nodulosae, hyalinae, aseptatae, ramae superae crassiores et bifurcatae; ovato-ellipsoidi vel oblongi, stipite brevi 45-86 x 27-44 μm ; ascospora 4-7, plerumque 6, 12-22 x 9-16 μm (Fig.2).

In Rosa webbiana Wall., Badrinath, Garhwal, U.P., 20.10.1984 et Holotypus in HCIO 37164, I.A.R.I., New Delhi, India.

Colonies amphigenous; mycelium persistent and effused; cleistothecia often gregarious in floccose patches but sometimes scattered, globose-depressed, 114-171 μm in diam., wall cells 9-18 μm wide; appendages 8-25 in number, 90-180 μm in length, very thick, upto 9 μm wide, more or less flexuose contorted, angularly bent and not nodulose, hyaline, aseptate, apex 3-4 times dichotomously branched, branching in regular pattern, ultimate branches broader and bifurcated; asci 8-14 in number, ovate ellipsoidal or oblong with a short stalk, 45-86 x 27-44 μm ; ascospores 4-7, usually 6, 12-22 x 9-16 μm .

This species differs from Microsphaera euphorbiae (Peck) Berk. & Curt. in having very thick appendages (9 μm wide), shorter in length, angularly bent but not nodulose, cleistothecia are larger in size. Ascospores ranging from 4-7 per ascus whereas in M. euphorbiae 3-6 ascospores per ascus were observed.

3. Phyllactinia phaseolina Ahmad, Agarwal & Sarbhoy sp. nov.

Coloniae amphigenae; mycelium evanescens, interdum persistens; cleistothecia dispersa, globosa ad sub-globosa

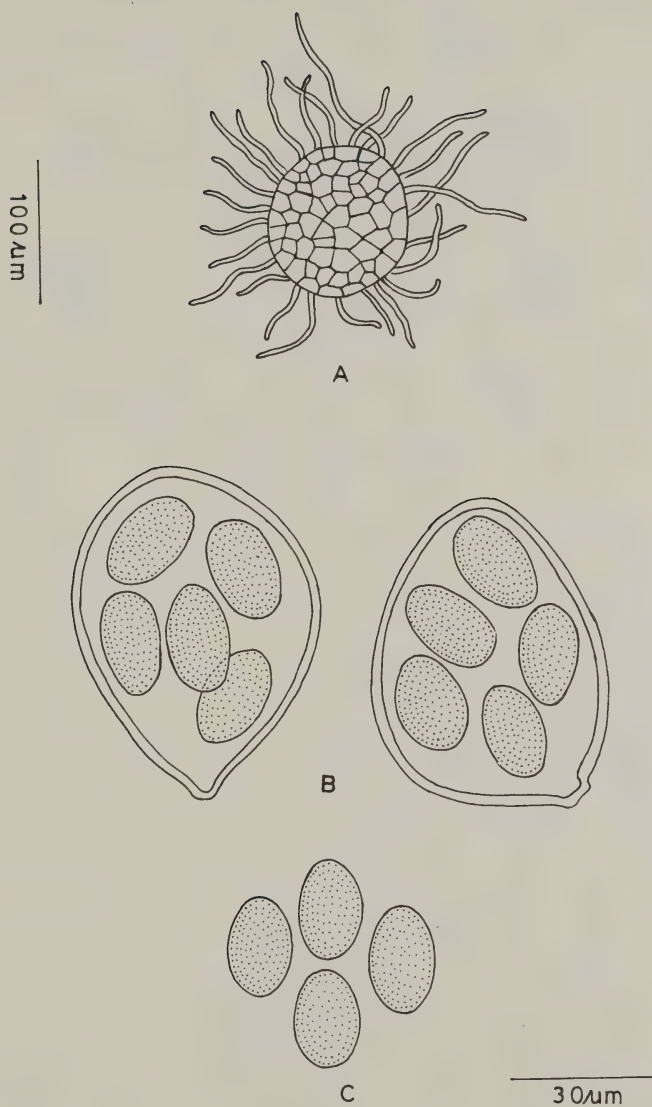


Fig.1. Erysiphe garhwalensis A, Cleistothecium
B, ascus with ascospores C, ascospores

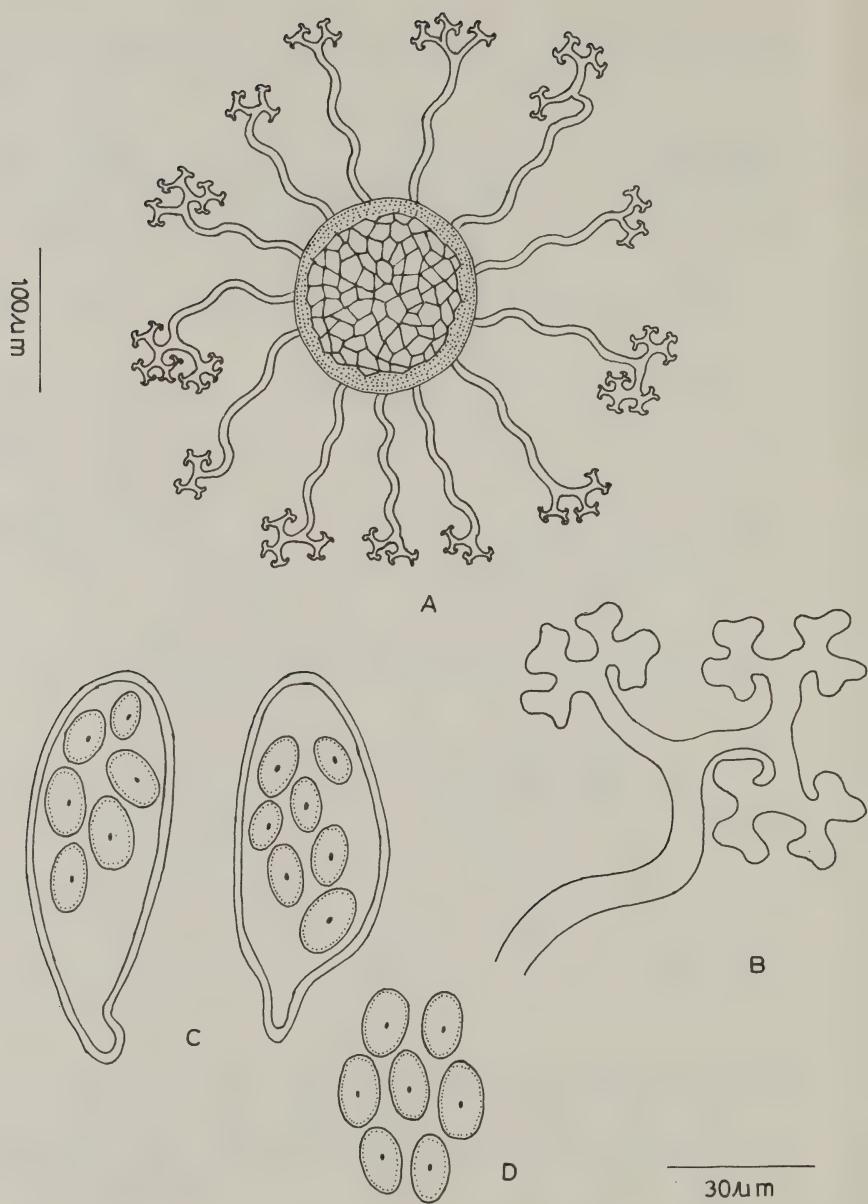


Fig.2 *Microsphaera indica* A, Cleistothecium
 B, appendages C, ascus with ascospores
 D, ascospores.

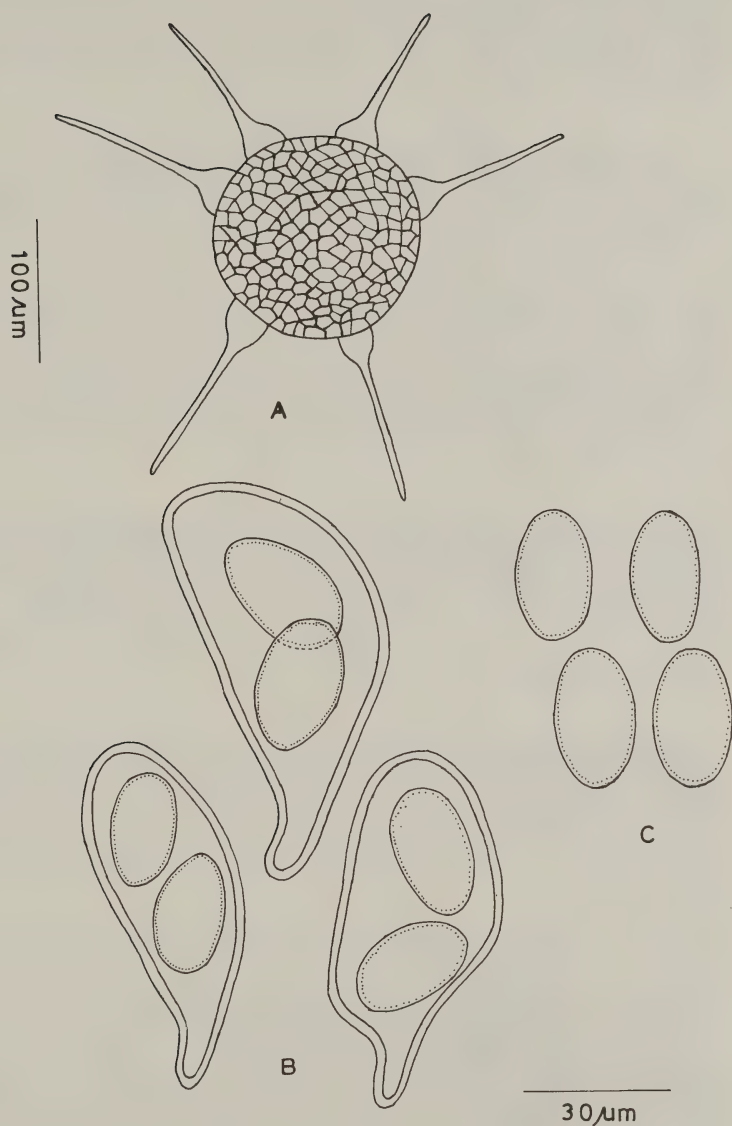


Fig.3. *Phyllactinia phaseolina* A, Cleistothecium
 B, ascus with ascospores C, ascospores.

150-230 μm in diam.; cellulae parietis 9-20 μm crassae; appendiculae 4-10 usque 6-8, 111-225 μm longae, rectae, aciculatae, ad basim bulbosae, hyalinae, aseptatae; asci 6-25, elongati, evati vel ellipsoidi, 54-84 x 25-40 μm ; ascospores semper 2, ellipsoidea vel ovaes, 24-33 x 15-21 μm (Fig.3).

In *Phaseolus trilobus* Ait., Joshimath, Garhwal, U.P., 22.10.1984 et Holotypus in HCIO 37165, I.A.R.I., New Delhi, India.

Colonies amphigenous; mycelium evanescent sometimes persistent; cleistothecia scattered, globose to subglobose, 150-230 μm in diam., wall cells 9-20 μm wide; appendages 4-10 in number usually 6-8, 111-225 μm in length, straight, acicular, bulbous at the base, hyaline, aseptate, asci 6-25 in number, elongate, ovate or ellipsoidal, 54-84 x 25-40 μm ; ascospores always 2 per ascus, ellipsoidal or oval, 24-33 x 15-21 μm .

The above species differs from *Phyllactinia moricola* (P.Henn.) Homma in possessing few appendages which are shorter in length, cleistothecia smaller having asci 6-25 per cleistothecium as against 5-16 in *P. moricola*.

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**A VA-MYCORRHIZAL FUNGUS,
GLOMUS GLOMERULATUM sp. nov.,
WITH TWO HYPHAL ATTACHMENTS AND SPORES FORMED
ONLY IN SPOROCARPS**

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SUMMARY

Glomus glomerulatum forms its chlamydospores by swellings of hyphae only in sporocarps. The spores are 40-70 μm in diam. and have a 4-9 μm thick wall which consists of a thick yellow-brown laminated outer wall and a thin hyaline inner wall in one wall group. The new species forms VA-mycorrhiza; it is known only from Colombia.

RESUMEN

Glomus glomerulatum forma sus clamidosporas por engrosamientos de las hifas en esporocarpos solamente. Las esporas tienen 40-70 μm en diámetro y la pared cual consiste en una pared externa gruesa y una delgada interna, tiene 4-9 μm en grosor. La nueva especie forma micorriza vesiculo arbuscular; solamente se la conoce de Colombia.

INTRODUCTION

At the Centro Internacional de Agricultura Tropical (CIAT), Palmira, Colombia, Pueraria phaseoloides was sown in a pot which contained a soil sample from the eastern plains of Colombia, the Llanos Orientales. Observing the spore production of Endogonaceous fungi in this pot, besides other VA mycorrhizal fungi many sporocarps were found. The spores separated from the sporocarps all had two attachments. For the confirmation that this species forms VA mycorrhiza single spore pot cultures were established.

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For the description of the wall of this fungal species Walker's (1983) terminology was used.

GLOMUS GLOMERULATUM sp. nov. Sieverding (Figures 1-3)

Sporocarpia sine peridio; sporocarpia pulla, globosa vel subglobosa vel plana-angulata, (290-) 400 x 500 (-675) μm diam.; chlamydosporae in sporocarpis per mycelium glomerulatae. Chlamydosporae fulvae vel fuscae, globosae vel subglobosae, 40-70 μm diam.; paries sporae e duobus stratis constans; stratum primum fulvum, laminatum, 4-9 μm crassum; secundum hyalinum, 0.5 μm crassum.

Sporae formatae sine ulla exceptione in sporocarpis; sporae per intumescitiam hypharum formatae inde sporae cum duabus hyphis conexae; hyphae sporarum fulvae, non-septae vel septae, 5-7 μm crassae. Formans mycorrhizam cum vesiculis et arbusculis.

Sporocarps dark brown with a greenish tint, globose, subglobose, rectangular or of flattened or irregular shape, (290-) 400 x 500 (-675) μm diam.; sporocarps formed by interwoven hyaline hyphae; hyphae 2-6 μm in diam. with 0.1-0.5 μm thick walls; hyphae septate or nonseptate. Sporocarps are without peridium; the surface of the sporocarp is knobby due to the appearance of spores. Spores in the sporocarp are clustered by mycelium and embedded in an unordered gleba. Sporocarps become compact and firm with age.

Chlamydospores yellow to brown, globose to subglobose, 40-70 μm diam. Composite spore wall is composed of two walls (walls 1 & 2) in one group (group A); wall 1 is yellow to brown, laminated and 4-9 μm thick, on the surface of this wall a layer of hyphae is often adherent but normally the spore surface is smooth; wall 2 is hyaline, membranous, 0.5 μm thick and normally adherent to wall 1 except when spores are placed in polyvinyl-alcohol-lactophenol (PVL) in which wall 2 can partly separate from wall 1.

Chlamydospores formed only in sporocarps; all chlamydospores have two hyphal attachments due to pattern of spore formation by intercalary swelling of nonseptate or septate hyphae, at irregular distances along the hypha; hyphal attachments yellow to brown, 5-7 μm diam., straight or recurved; hyphal attachments generally cylindric rarely funnel-shaped or weakly constricted at the point of attachment; the pore of the hyphal attachment is 1-2 μm in diam., the pore is closed by the second wall or by a septum. Spore

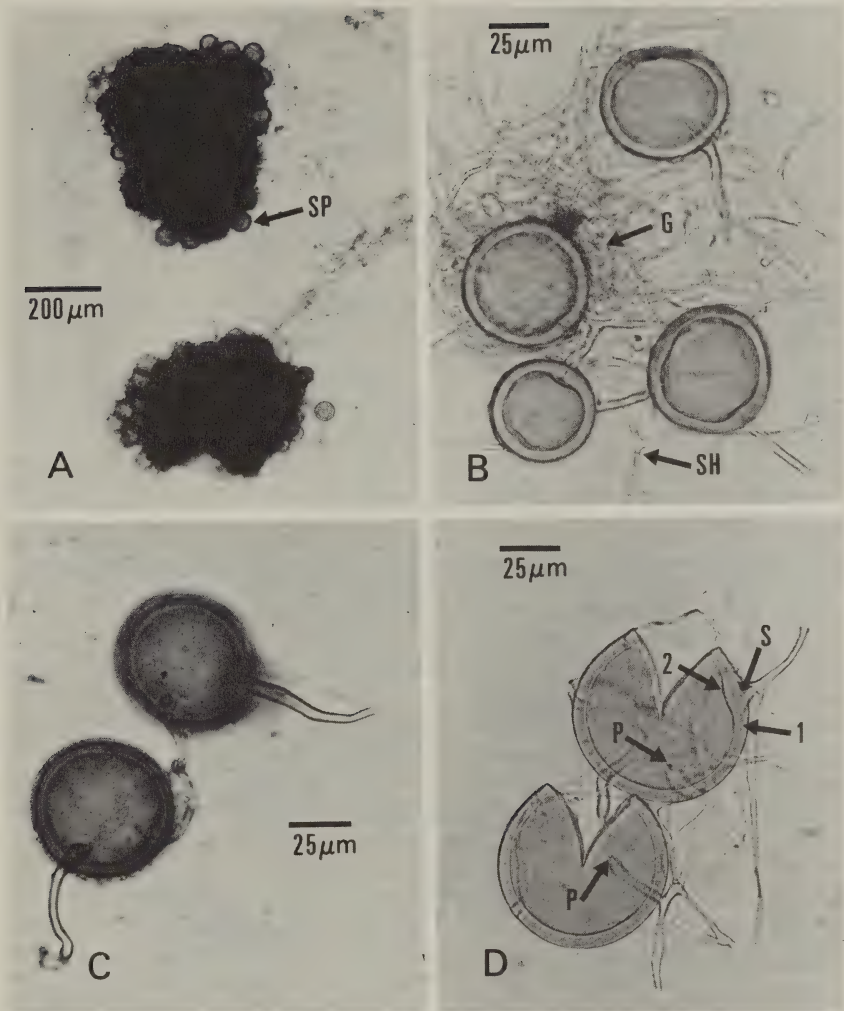


Figure 1. *Glomus glomerulatum* A) Two sporocarps; chlamydospores (SP) appear on the surface; B) Chlamydospores with two hyphal attachments; the specimen was separated from a sporocarp; note the septate hyphae (SH) and gleba (G); C) Chlamydospores are formed by swelling of a hypha giving the appearance of "beads" when spores are separated from a sporocarp; D) Broken spores with two walls (1,2); note the pore of a hyphal attachment in the wall (P) and a septum (S) closing the pore. All specimens mounted in poly-vinyl-alcohol-lactophenol (PVL).

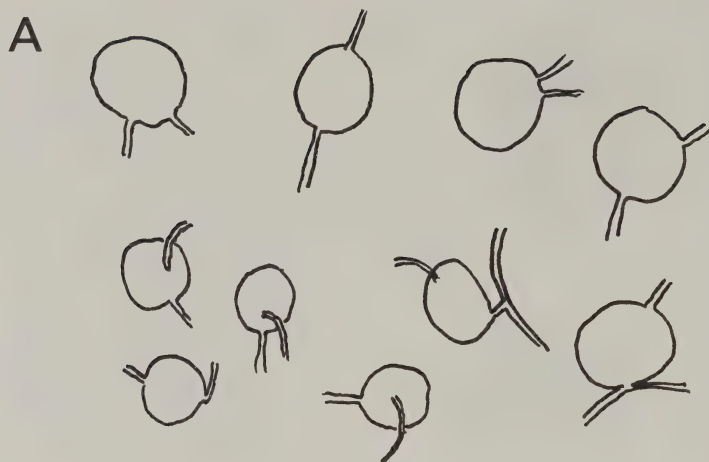


Figure 2A. Some examples of the different positions of hyphal attachments on the chlamydospores; drawings are not to scale.

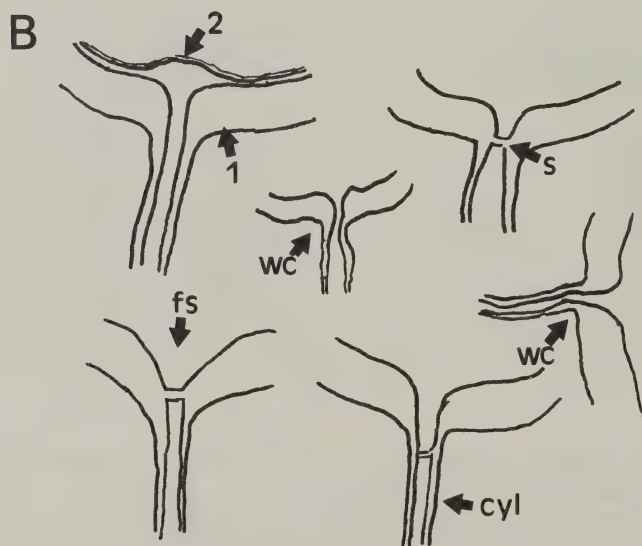


Figure 2B. Different shapes of hyphal attachments observed; dominant was the cylindric shape (cyl), some were funnel-shaped (fs) or weakly constricted (wc); the pores were closed by wall 2 or by septa; these drawings are not to scale.

contents hyaline, oily. Forms vesicular-arbuscular mycorrhiza.

TYPE: Colombia, Valle, Palmira, Centro Internacional de Agricultura Tropical, culture no. C-163-4 on Pueraria phaseoloides. Holotype GOET, isotypes OSC and COL.

ETYMOLOGY: Latin, glomerulatum (clumped), referring to the exclusive compact formation of chlamydospores in sporocarps.

DISTRIBUTION: Glomus glomerulatum is only known from Colombia; it was isolated from pot cultures inoculated with soil from an unspecified site in the eastern plains of Colombia, Vichada, near the Meta river. The analysis of the soil sample from the natural savanna gave: 4.2% organic matter, pH 4.9, 3.5 mg P / kg soil (Bray II extractable), 1.3 meq. Al, 0.19 meq. Ca, 0.05 meq. Mg and 0.12 meq. K / 100 g soil. The formation of VA mycorrhizae was confirmed on Pueraria phaseoloides.

DISCUSSION: Glomus glomerulatum is only formed in sporocarps and the spores have generally two hyphal attachments because spores are formed by swellings in the hyphae at irregular distances giving the appearance of beads if spores are carefully separated from the sporocarp (Fig. 1C). However, as these swellings occur in a compact cluster, the hyphal attachments are rarely opposite each other on the spore (Fig. 2A). It may be difficult to find the second attachment on some specimens; the spore surface should be checked carefully as the attachment may have been broken off at the pore.

On less than one percent of spores, I observed one or three hyphal attachments. In the first case the spore formation was Acaulospora-like, i.e. one side of a hypha swelled for chlamydospore formation; in the second case it appeared that spore formation was by swelling of a hypha at the point where the hyphae branched, thus leaving the spore with three attachments.

Hyphal attachments generally were cylindric but on some specimens weakly constricted or funnel-shaped attachments were observed (Fig. 2B). On most specimens the pore of the hyphal attachment was closed by the second wall. On 25% of the specimens the pore was closed by a septum (Fig. 1D and 2B). Closure of pores by septae may occur on both attachments simultaneously, or only one of the two pores may be closed by a septum. Closure of pores by septum was rare when chlamy-



Figure 3. Murograph (after Walker, 1983) of Glomus glomerulatum with laminated wall 1 and membranous wall 2 adherent in one wall group A.

dospores were formed within mycelium with nonseptate hyphae; on the other hand septae were frequent in mycelium with septate hyphae.

Chlamydospores, especially when separated from younger sporocarps, often contained on the surface of wall 1 parts of the gleba with some debris; this could be confused with a wall-like structure. Specimens separated from old sporocarps had a smooth spore surface because with age the gleba hardens and breaks off when the chlamydospore is removed from the sporocarp. Wall 1 of the spores is always distinct (Fig. 3). Wall 2 is best observed on specimens, mounted in PVL, at the point of the hyphal attachment. There wall 2 is separated from wall 1 (Fig. 1B, 1D). Because at this point the wall appears flexible, I indicated it as a membranous wall in the murograph (Fig. 3). Because wall 2 remains adherent to wall 1, on broken spores, wall 2 was not separated from wall 1 in the murograph.

Gerdemann and Trappe (1974) stated that formation of chlamydospores with two hyphal attachments (although rare) is possible in the genus Glomus; therefore, intercalary chlamydospore formation by Glomus glomerulatum does not preclude placing this species in the genus Glomus since there is no evidence of sexual reproduction. Chlamydospores may be terminal and/or intercalary, after Hawksworth, Sutton and Ainsworth (1983). Occasionally two or more hyphal attachments have been reported on spores from other Glomus spp., i.e. from Glomus albidum Walker & Rhodes, Glomus ambisporum Smith & Schenck, Glomus etunicatum Becker & Gerd., Glomus geosporum (Nicol. &

Gerd.) Walker, Glomus heterosporum Smith & Schenck, Glomus lacteum Rose & Trappe, Glomus maculosum Miller & Walker, Glomus monosporum Gerd. & Trappe, Glomus mosseae (Nicol. & Gerd.) Gerd. & Trappe, Glomus multicaule Gerd. & Bakshi and Glomus pallidum Hall. In some cases the second attachment was the result of a germ tube through the spore wall as with G. albidum and G. pallidum (Walker and Rhodes, 1981). Glomus glomerulatum differs from the above species by colour, shape and/or formation of spores in sporocarps. Only the pigmented spores of G. ambisporum and G. heterosporum are formed in sporocarps and have, to a limited extent, two hyphal attachments. These two species are bimorphic, the spores of these species are distinctly arranged in a sporocarp and the spores are larger than those of G. glomerulatum. I established pure pot cultures and never found G. glomerulatum to be bimorphic.

ACKNOWLEDGMENTS

I wish to thank J.L. Spain and N.C. Schenck for review of the manuscript and Prof. S. Rehm for reviewing the latin description. The study was conducted in the frame of the CIAT Mycorrhiza Project which is financially supported by the German Agency for Technical Cooperation, GTZ, Eschborn, West Germany.

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SCLEROTINIA ANTARCTICA SP. NOV., THE TELEOMORPH OF THE FIRST FUNGUS DESCRIBED FROM ANTARCTICA

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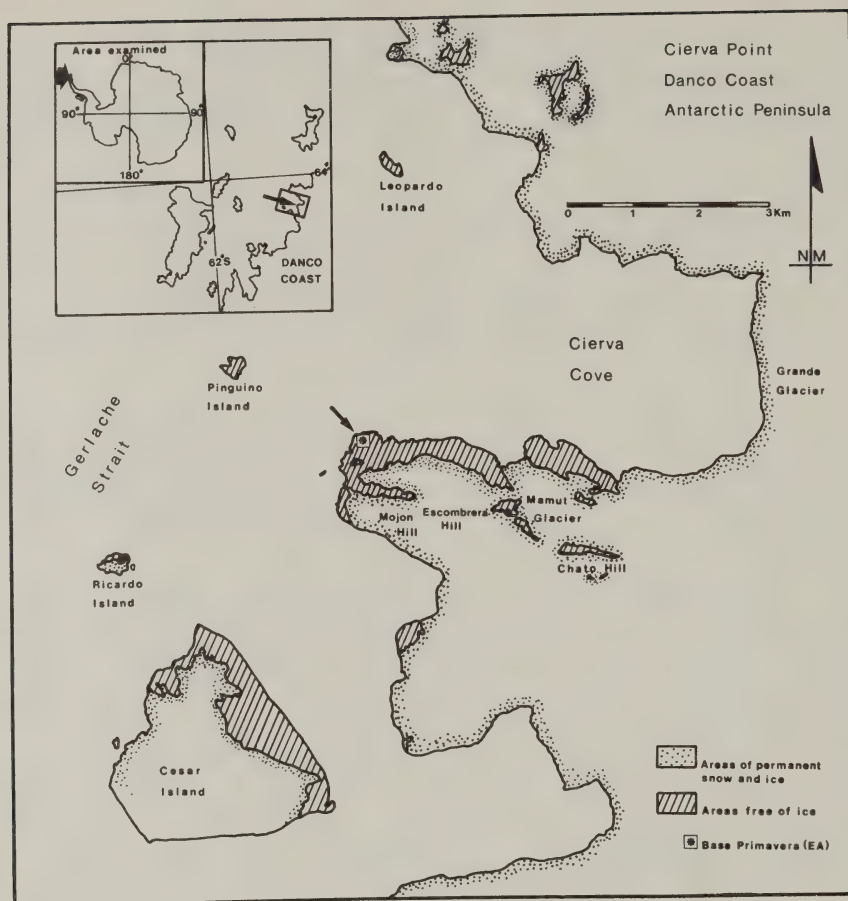
There are discrepancies concerning the first fungus recorded for the Antarctic Continent. According to our investigations, the first fungus described was Sclerotium antarcticum Bommer et Rousseau (1900:645), from the Belgian expedition commanded by A. de Gerlache de Gomery (1897-1899). The name was accepted by Saccardo and Sydow (1902:1109).

The original description, reprinted in Bommer & Rousseau (1905:11) stated: "*Liberum, inaequilater, globosum vel elongatum, 2-3 mm longum, quandoque puncto prominulo praeditum, intus album, superficiei corrugata, cute tenui, membranaceae, atra, bebe limitata, ex elementis cellularibus valde sclerosis constituta, aspectu carbonaceo; substantia interiore ex hyphis cylindraceis, materie gelatinosa immersis, formata. Intra culmos Airae antarcticae (N° 173)". The locality was "Terre de Danco", 2 Février 1898 with an additional remark: "Ce Sclérote offre une très grande analogie d'aspect et de structure avec celui de Collybia racemosa. Il est possible qu'il se rapporte à une Agaricée voisine de cette espèce".*

Although Singer and Corte (1962:5) recognized the find recorded by Bommer & Rousseau (op.cit), they were suspicious about the identity of the material: "...we do not know if the collected material existed so far but the description is exceedingly vague and could be regarded to a sterile fungus free, old or fallen from the original substrate, a seed's fungus, a pupa or any other objet from unknown origin penetrated by hyphae". A foot-note on p.5 added: "...that when Singer visited the Jardin Botanique de L'Etat (Bruxelles) he could not find either in the general collection or in Bommer and Rousseau's Herbarium the fungus in question", adding "...that the first antarctic fungus whose systematic position is known has been mentioned in a treatise on Arctic Flora (1954) and described as a new species Omphalina antarctica Singer, (1956:16)".

One of us (H.A.S.) visited Antarctica during the "Campana Antártica Argentina de verano, 1985-86" and was stationed at Base Primavera, Danco Coast (64° 09'S, 60° 57'W) (see map) in January and February searching for fungi in the surroundings.

He not only found Sclerotium antarcticum Bommer & Rousseau on leaves of Deschampsia antarctica Desv. (= Aira



Map of the Antarctic peninsula. Arrow indicates the collecting site.

antarctica), but also apothecia of the Sclerotinia-type arising from free sclerotia.

Ecological remarks

The field temperature during January-February 1986 at Base Primavera was between -1.4°C and 8°C . Part of the ground was free of ice and covered by a discontinuous carpet of mosses intermixed with a few phanerogams. Most abundant are mosses, determined as Drepanocladus aff. revolvens (Sw.) Warmst., Bryum dichotomum Hedw., Pohlia sp., and Polytrichum juniperinum Hedw. var. affine (Funch.) Brid. Phanerogams were Colobanthus quitensis (Kunth.) Bartl. and Deschampsia antarctica Desv.. This carpet of mosses is soaked in water at this time of the year, and amongst them, on dry leaves, occasionally on glumes or culms of Deschampsia antarctica, tuberoid sclerotia are developing, from which arise apothecia whose cups emerge over the

mosses. This occurs near the crevices where the melting snow forms small creeks ("chorrillos") thus forming very humid microhabitat. In places near the creek, higher and more exposed to winds, Deschampsia antarctica was also found with sclerotia, but in sterile condition.

As the collection was rich enough, ungerminated sclerotia were separated from the fertile ones. From the latter preservation was made in two ways: dried and in 3% formaldehyde. The infertile sclerotia were treated as follows.

Methods

A. Treatment of sclerotia

1. Sclerotia with apothecial primordia collected in the field were transported to the Base laboratory (14-18°C) and put in a Petri dish with filter paper properly sterilized and saturated with sterile water during 15 days. Later they were transferred to the Instituto Spegazzini (La Plata) and placed at 5°C. After two months no progress was observed.

2. Fresh ungerminated sclerotia in wet condition were inoculated in Martin's medium and treated as the previous ones. After two months a white mycelium covered the dish surface and small sclerotules appeared on the mycelium. No macro- nor microconidia were observed.

3. Dry sclerotia superficially sterilized with successive washings of distilled water were transferred to Petri dishes with PGA, giving abundant mycelium.

4. Dry sclerotia were superficially sterilized with hypochlorite solution during 10 minutes according to Schumacher and Kohn (1985); and later transferred to PGA. After two month no sign of growth was detected.

B. Treatment of ascospores

Puffing from field apothecia was collected on a Petri dish with Martin's medium. Ascospores were then transferred to PGA and maintained at 18°C. No germination was observed after two months.

It was possible to stain ascospore nuclei with Giemsa with good results: from 4 to 9 nuclei were observed, most commonly 7-8 nuclei. (Fig.3)

Results

It is a problematic task to assign the Antarctic material to a sclerotiniaceous genus, taking into account that several circumscriptions of the genera are known: Nannfeldt (1932), Whetzel (1945), Buchwald (1947), Dennis (1956) and Kohn (1979 a,b), particularly when, as in our case, few culture data are available.

We thank Dr. R.P. Korf who drew our attention to one species whose host is a Gramineae: Sclerotinia borealis Bub. & Vleugel, collected in Sweden, Norway, Finland, U.S.S.R. and Canada (Groves & Bowerman, 1955). This is a closely related species to our "Sclerotinia", if one compares it with those authors' description. But Kohn (1979 a:885) transferred S. borealis to Myriosclerotinia Buchw.-M. borealis (Bub. & Vleug.) Kohn on account of its relationship with cypericolous and juncicolous species. Later, in their monograph on Myriosclerotinia, Schumacher & Kohn

(1985:1632) excluded it from this genus, stating: "Ciborinia may well be most appropriate generic accomodation, but the genus as presently circumscribed is heterogeneous and needs monographic revision".

There are several characteristics in common between our Antarctic fungus and Sclerotinia borealis Bub. & Vleug., viz: a) sclerotia develop superficially on the withered leaves of the host, ultimately becoming detached from the host; b) a microconidial anamorph (Myrioconium type) is not formed in the host; c) ascospores are devoided of guttules and octonucleate (in the Antarctic fungus it varies from 4-9, usually 7-8).

Features that separate the Antarctic fungus from S. borealis are: ascospores are larger in the latter (15) 17-21 (25) x 6-8 μ m as well as the asci (175-200 (238) x 11-14 μ m). Also specific host and geographical distribution is different. This is indicative that we are dealing with a different species.

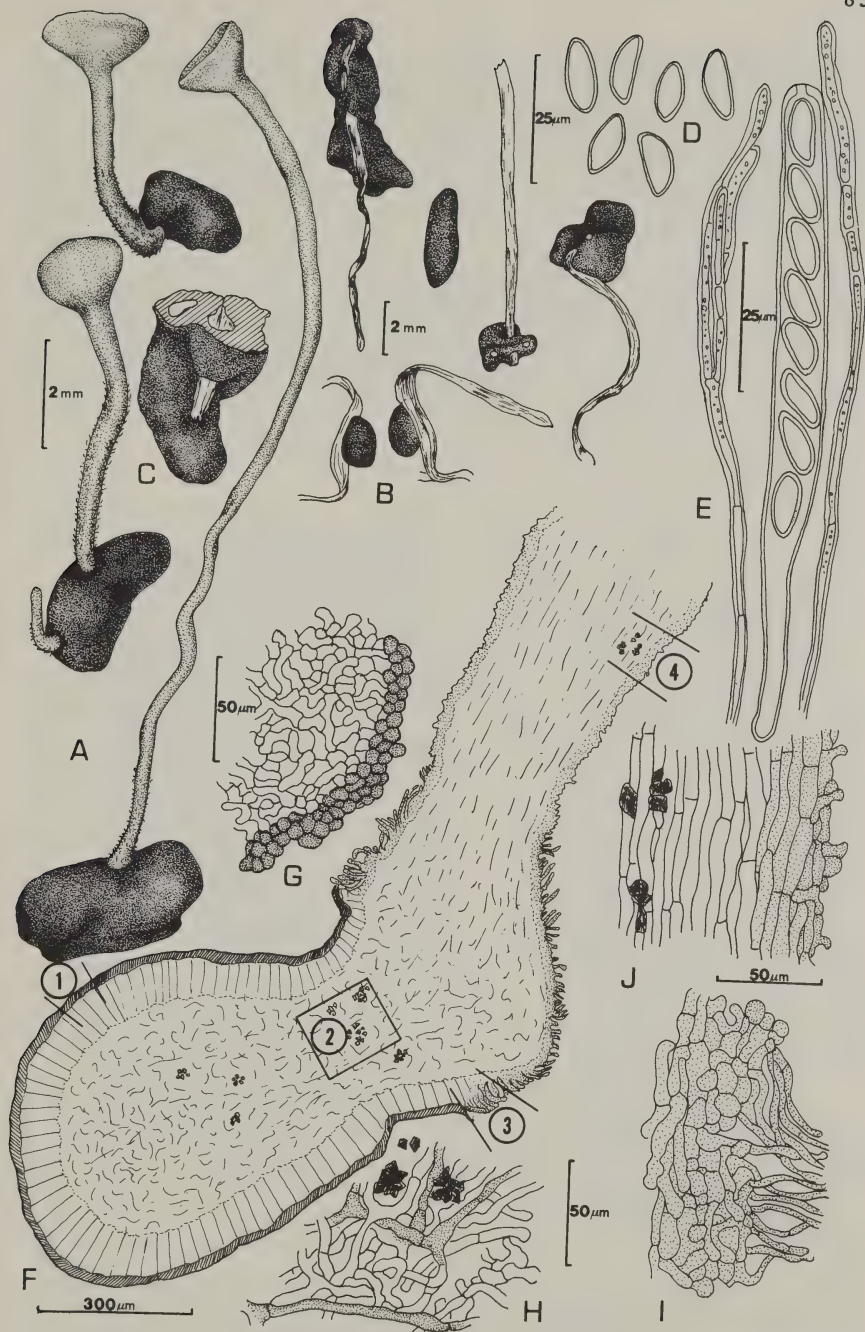
In view of the arguments exposed above, we believe that, until more cultural work is carried out with the Antarctic material, it is better to assign it to Sclerotinia Fuck. instead of creating a new genus to accomodate S. antarctica and S. borealis or place them in Ciborinia Whetzel (1945:667). We think that Ciborinia is less related to our fungus than Sclerotinia, because the former has "sclerotium circular or the discoid type, ovate-elliptical in outline, thin, flat, and on drying somewhat concave-convex... and spermodermium subcuticular along the veins". Both features are absent in S. antarctica n.sp., particularly regarding the sclerotium type, where much emphasis has been put by the original author, Whetzel (1945:662-664) and Kohn (1979:884).

The connection between Sclerotium antarcticum Bomm. & Rouss. (anamorph) and Sclerotinia antarctica Gamundi & Spinedi (teleomorph) is evident: same host, same locality, and the sclerotium of the holomorph according with the protologue given by Bommer & Rousseau (1905:11). The priority of the teleomorph name obliges us to select a HOLOTYPE for the new species (Art. 59.6, Int. Code Botanical Nomenclature, 1983). An ISOTYPE was sent to BR, where the TYPE of Sclerotium antarcticum Bomm. & Rouss. is registered as lost, according to a letter from J. Rammeloo (29-VII-1986) from Nationale Plantentium van Belgie, Meise.

SCLEROTINIA ANTARCTICA nov. sp.

SCLEROTIA typus "sclerotioide" Whetzel, super folia, raro super gluma ut culmus, interdum ad folia circumdata, cylindrica, tuberosa, fusoidea, elongata vel compressa, denique libera, (1.5) 2-6 x 1-2 mm; cortex nigra, textura globulosa, 24-26 μ m crassae; medulla alba ex textura intri-

Fig.1.A. Sclerotia with apothecia, B. Sclerotia on host. C. Section of sclerotium, a leaf included. D. Ascospores. E. Asci and paraphyses F. Longitudinal gross section of sclerotium and stipe. G. Detail of 1, in F. H. Detail of 2, in F. I. Detail of 3, in F. J. Detail of 4 in F.



cata, hyphis hyalinis in matrix gelatinosa immersis.

APOTHECIA solitaria, raro duplex ex sclerotiis orientia, discoidea, stipitata, glabra vel furfuracea, umbrina. Discus 1.1-4.5 mm diam. Stipite cylindricus, pubescentes, 4.5-15.6 x 0.25-0.8 mm. Excipulum corticalis 24-50 μ m crassus, ex textura globulosa, claro brunneis, cellulis tenui-tunicatis. Excipulum medullaris ex textura intricata, hyphis pallide ochraceis 3.6-7.2 μ m crassis. Asci octospori, cylindrici, poro jodo coerulescentibus, 156-170 x 7.2-9.6 μ m. Ascosporae ellipsoidea, uniseriatae, hyalinae vel laevi, ochraceae, sine guttulae (9.6) 14.4-16.3 x 5.3-6.2 μ m, 4-9 nucleatae. Paraphyses filiformes, simplex vel bifurcatae, 1.4-2.4 μ m cr. Margine 30-50 μ m crasso, ochraceo, ex textura porrecta. Stipite ex textura porrecta, hyphis medullaris hyalinis, corticalis brunneo-ochraceis, pili ochraceis 2.4-4.8 μ m vestitum.

Matrix: Deschampsia antarctica Desv.

Holotypus: LPS 44123; Isotypus: BR

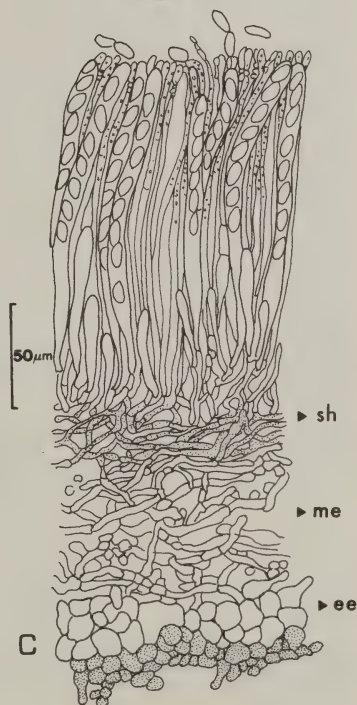
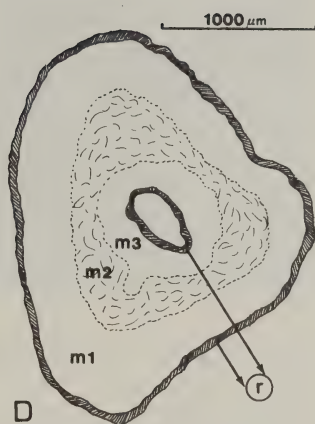
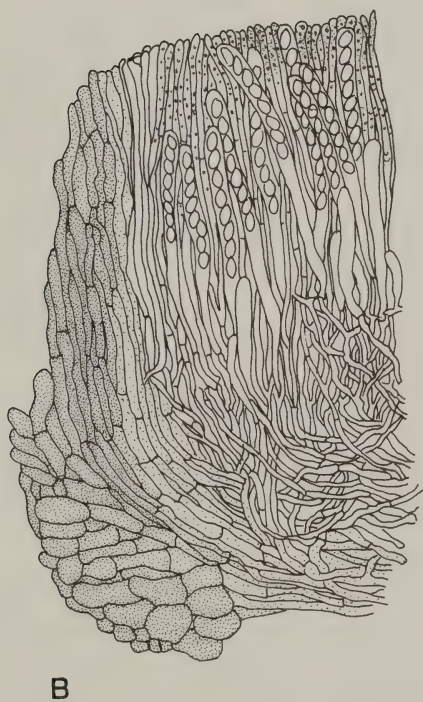
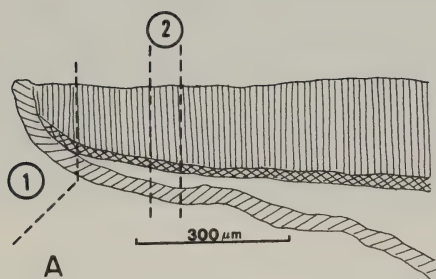
SCLEROTIA sclerotioid, arising on leaves, rarely on glumes or floral scapes, sometimes encircling the leaves (Fig.1,B,C; fig.2,D), but never containing susceptible tissue of the host in the medulla; diversely shaped (cylindrical, fusoid, elliptical, tuberoid elongated or compressed), with a rugulose, black surface, (1.5) 2-6 x 1-2 mm; with a black outer rind and white medulla. In culture developing a white, superficial mycelium and sclerotules. Medulla (Fig.2, m2) of loose "textura intricata", hyphae on a gelatinose matrix Toluidine-Blue +, containing crystals that dissolve in 50 % KOH; hyphae hyaline, 3-4.5 μ m diam.; the outer zone (m1, m3,) of a more compact texture; rind 24-36 μ m thick, formed by 2-3 layers of black cells 8-14 μ m diam. ("textura globulosa"). When a sclerotium encircles the leaves (Fig.1.B, 2,D) the rind (r) is double, an outer free layer and an inner one adherent to the leaf, repeating in transection the m1 layer of the medulla (Fig.2, D m3) under the inner rind.

APOTHECIA born singly (rarely in twos) from a sclerotium, cup-shaped stipitate, glabrous to furfuraceous, with an acute margin umber to pale umber (Rayner, page 1, L, M-15 M-17), 1.1-4.5 mm diam. Stipe cylindric, tomentose, particularly in the lower part, umber, becoming darker near the base, very variable in length, 4.5-15.6 x 0.25-0.8 mm (Fig.1 a, fig. 2,A).

EXTERNAL EXCIPULUM thin, 24-50 μ m, dark ochre, formed by 2-3 layers of globose to subglobose, thin walled cells, 17-20 x 10-26 μ m, the superficial ones smaller (6-11 x 5-10 μ m), darker, forming a sort of furfuraceous covering (Fig. 2, A,B,C,ee).

MEDULLARY EXCIPULUM (90) 120-160 μ m thick, of tightly "textura intricata" of pale ochre hyphae 3.6-7.2 μ m diam.,

Fig.2. A. Sketch of a section of apothecium, with different layers. B. Section of an apothecium, at the margin. C. Median section of an apothecium: sh, subhymenium; me, medullary excipulum; ee, external excipulum. D. Cross section of a sclerotium encircling a leaf: r, rind; m1, m3, compact medulla; m2, loose medulla.



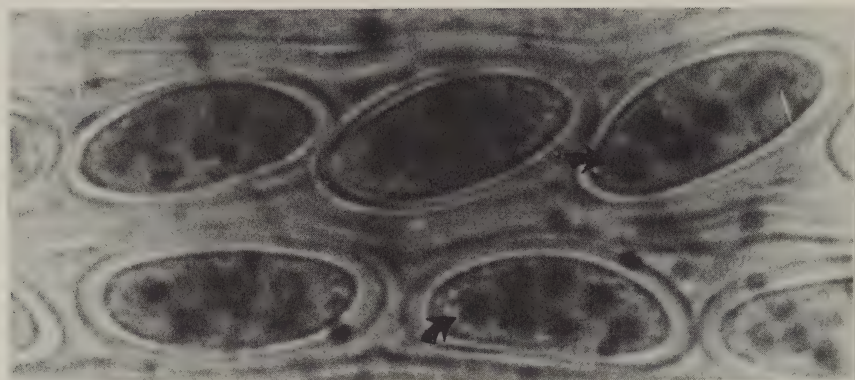


Fig.3 Ascospores with nuclei (Giemsa).

walls fairly gelified. ASCI octosporous, cylindrical, pore channel J+, thickened and flat at the apex, 156-170 x 7.2-9.6 μm . PARAPHYSES filiform, simple or bifurcate, containing ochre guttulae, slightly longer than asci, 1-2.4 μm broad. ASCOSPORES uniseriate, ellipsoidal, asymmetrical, smooth, without guttulae, (9.6) 14.4-16.3 x 5.3-6.2 μm , 4-9 nucleate (mostly 7-8), hyaline to pale ochraceous. (Fig.1,E,D,2,A,B,C).

SUBHYMENIUM of tightly interwoven hyphae, ochraceous. (Fig. 2,C,sh). STIPE composed of a hyaline medulla of "textura porrecta" and a cortex 50-70 μm thick, pale ochre, same structure, non gelatinose, containing crystals and ending in free superficial hairs that form a thick tomentum, specially in the lower part; hairs not gelatinose, ochre, 2.4-4.8 μm diam. (Fig.1,F,G,H,I).

MARGIN of apothecium 30-50 μm thick, not elevated from the hymenial surface, of "textura porrecta". (Fig.2,B).

HOLOTYPE: Antarctica, Antarctic Peninsula, Danco Coast, Base Primavera (Cierva Point), Leg. H.A.Spinedi, 6-II-1986, on leaves glumes or scapes of Deschampsia antarctica Desv. (Gramineae), LPS 44123. ISOTYPE: BR.

Acknowledgments

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**The genera of *Rhizoctonia*-like fungi:
Ascorhizoctonia, *Ceratorhiza* gen. nov.,
Epulorhiza gen. nov., *Moniliopsis*, and
Rhizoctonia.**

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Fungi that produce *Rhizoctonia*-like anamorphs occur in four groups of higher fungi: ascomycetes, ustomycetes, homobasidiomycetes, and heterobasidiomycetes. These fungi are, with few exceptions, root associated and sclerotial-forming species. Many are rhizopathic but a number are rhizotrophic for orchids (Warcup & Talbot, 1966, 1967, 1971, 1980; Warcup 1971, 1975, 1981; Harley & Smith, 1983).

The septal morphologies of the four major groups of higher fungi are distinctive. Filamentous ascomycetes have electron transparent septa with large pores and two or more associated Woronin bodies. The septa of basidiomycetes are three layered (dark/light/dark in electron micrographs): ustomycetes have simple septa, small pores with acute rims, and distinctive 5S rRNA patterns; homobasidiomycetes have dolipore/parenthesome septal complexes with parenthesomes that are generally perforate; heterobasidiomycetes have dolipore/parenthesome septal complexes with parenthesomes that are imperforate or vesiculate (see Moore, 1985).

Septal ultrastructure studies of a number of mycobionts, including those of some orchids, have shown the ascomycete type of septum to occur in *Calluna vulgaris* (Bonfante-Fasolo & Gianinazzi-Pearson, 1979) and *Complexipes moniliformis* (Thomas & Jackson, 1982; see also Yang & Korf, 1985b); the homobasidiomycete (perforate parenthesome) type of septum to occur in *Corallorhiza trifida* (Nieudorp, 1972); and the heterobasidiomycete (imperforate parenthesome) type of septum to occur in *Dactylorhiza* (*Dactylorchis*) *maculata* (Strullu & Gourret, 1974) and, again, *Calluna vulgaris* (Bonfante-Fasolo, 1980.).)

Identifying these anamorphs is difficult. A number bear the names of their host plants. This system of naming, although convenient, masks the fact that a specific genome may have different morphological or physiological expressions on different substrates (e. g., Parmeter et al., 1967; Ogoshi et al., 1983). The hyphae may be composed of binucleate or multinucleate cells (see Burpee et al. 1978) and may form clamp connections. After the elucidation of septal micromorphology in the higher fungi (Moore & McAlear, 1962) it was found that the dolipore of the basidiomycetous species of these fungi could be resolved by light microscopy (see Tu & Kimbrough, 1973); electron microscopy, however, is required to determine whether the parenthesomes are perforate or imperforate (see Moore, 1985). Hyphal anastomosis has also been used extensively as an aid to help determine the degrees of relatedness between strain groups (Parmeter et al., 1967; Burpee et al., 1980; Ogoshi et al., 1983). A comparative and developmental study of a number of sclerotial fungi, *Rhizoctonia*-like and others, has been made by Tu (Tu & Kimbrough, 1975a, 1978; Tu et al., 1977). The anamorph genus *Rhizoctonia* is heterogeneous. The type species, *R. crocorum* (Pers.) DC: Fr., is the anamorph of *Helicobasidium brebissonii* (Desm.) Donk (= *H. purpureum* Pat., the type species of the genus; see Donk, 1958; 1966). *R. crocorum* has a 5S rRNA sequence that allies it with *Ustilago*, *Sporidiobolus*, and *Rhodospiridium*, quite distinct from the doliporous species (Walker & Doolittle, 1983). *H. mompa* Tanaka has a simple-pored basidiomycete-type septa (Bourett & McLaughlin, 1986) and some other *Helicobasidium* species also have simple pores (Oberwinkler & Bandoni, 1982). These observations indicate that *Helicobasidium* is a ustomycete (Moore, 1980).

The combination of teleomorph and septal morphology allows these forms to be sorted into separate genera. The ascomycete fraction is represented by species with pezizalean teleomorphs. *Ascorhizoctonia* Yang & Korf (1985a), type *A. praecox* Yang & Korf, was erected for anamorphs of *Tricharina* (Yang & Korf, 1985a, b). They described six new species and transferred *R. hiemalis* Saksena & Vaartaja. The typification of *R. hiemalis* is clouded. When Saksena & Vaartaja (1960) originally described it no teleomorph was known; they specified their "No. 2785, Type" and stated that cultures had been deposited in the Centraalbureau voor Schimmelcultures and the American Type Culture Collection. The name *R. hiemalis*, however, is not validly published because the authors failed to designate a type specimen; this also

applies to the three other species described by Saksena & Vaaraja (1960). (The International Code of Botanical Nomenclature states, Art. 9.5, that "Type specimens of names of taxa must be preserved permanently and cannot be living plants or cultures.") In a subsequent paper Saksena & Vaaraja (1961) reported that *R. hiemalis* was non-pathogenic. Yang & Korf (1985a), unable to locate any specimens of *R. hiemalis*, designated dried cultures made from ATCC 14016, "a subculture from the original 'type' isolate 2785" assessed as CUP 61622, as the Neotype specimen. They also remarked that the ATCC isolate had degenerated but that it did produce some terminal chlamydospores on the surface of a water agar plate which were similar in appearance to those illustrated by Whitney & Parmeter (1964). Whitney & Parmeter (1964) using cultures obtained from the Canadian Department of Forestry, the ATCC, and the CBS were able to generate numerous apothecia from the Canadian isolate and, in a later trial, the CBS isolate; no mention is made of fruiting from the ATCC isolate. Warcup & Talbot (1966), who stated '... only when type cultures were used do we claim to relate *Rhizoctonia* species to their perfect states.', were able to induce apothecia, presumably from the holotype Isolate 2785. The contra-indication comes from Walker & Doolittle (1983). Their report shows ATCC 14016 to have the same insertion in the 107 position of its 5S rRNA as *R. crocorum*. They doubted that this isolate was an ascomycete. There are two basic problems here. One is the affinities of ATCC 14016. It could be a mixed culture (*rhizoctonia sclerotia* are notoriously variable), or, if not, electron microscopy could readily establish if it is an ascomycete, a ustomycete, or a basidiomycete proper. The second problem is to obtain authentic material of *R. hiemalis*, the anamorph of *Tricharina hiemalis*: the best way, surely, would be to establish cultures from fresh ascospores and redescribe the anamorph. The teleomorph of *Rhizoctonia rubiginosa* Sappa & Mosca is also ambiguous. Warcup & Talbot (1966) using an isolate that Saksena & Vaaraja (1961) had identified as *R. rubiginosa*, as well as two other similar isolates from different sources, were able to generate apothecia of *Iodophanus carneus* (Pers. ex Pers.) Korf (= *Ascophanus carneus* (Pers. ex Fr.) Boud.). They also noted that the anamorph of *Iodophanus carneus*, *Oedocephalum glomerulosum* (Bull.) Sacc., was produced by all their cultures. Saksena & Vaaraja, (1961) state that their isolate is nonpathogenic.

The forms belonging to the basidiomycetes proper have either dikaryotic or multinucleate hyphal cells. The

teleomorphs of the former group are mostly species of *Ceratobasidium*, those of the latter group *Thanatephorus* or *Waitea*, and there is also a small mixed segregate associated with jelly fungi. Three genera, two of which are new, are proposed for these aggregates: *Ceratorhiza*, *Epulorhiza*, and *Moniliopsis*.

* * *

CERATORHIZA Moore, gen. nov.

Rhizoctonia simile. Hyphae dikaryoticus; septum doliporus cum parentheses perforatus; teleomorphosa *Ceratobasidium*. Species typica *Rhizoctonia goodyerae-repentis* Constantin. Etym. *cerato* de *Ceratobasidium* + *rhiza*, Greek, root.

Ceratorhiza cerealis (van der Hoeven) Moore, comb. nov.

Basionym: *Rhizoctonia cerealis* van der Hoeven, Neth. J. Pl. Path. 83(1977): 191.

Teleomorph: *Ceratobasidium cereale* Murray & Burpee, Trans. Brit. Mycol. Soc. 82(1984): 172.

Ceratorhiza fragariae (Husain&McKeen) Moore, comb. nov.

Basionym: *Rhizoctonia fragariae* Husain & McKeen, Phytopathology 53(1963): 533.

Teleomorph: *Ceratobasidium fragariae* nom. nud. (Kohmoto et al., 1981).

[comb. nov.]

Ceratorhiza goodyerae-repentis (Constantin) Moore, \

Basionym: *Rhizoctonia goodyerae-repentis* Constantin, Rev. Gén. Bot. 32(1920): 533.

Teleomorph: *Ceratobasidium cornigerum* (Bourd.) Rogers, (Warcup & Talbot, 1966).

Ceratorhiza ramicola (Weber&Roberts) Moore, comb. nov.

Basionym: *Rhizoctonia ramicola* Weber & Roberts, Phytopathology 41(1951): 618.

Teleomorph: *Ceratobasidium ramicola* Tu, Roberts & Kimbrough, Mycologia 61(1969): 781.

EPULORHIZA Moore, gen. nov.

Rhizoctonia simile. Septum doliporus cum parentheses imperforatus; teleomorphosa heterobasidiomycetum. Species typica *Rhizoctonia repens* Bernard. Etym. *epulo*, Greek, guest at a banquet + *rhiza*, Greek, root.

***Epulorhiza repens* (Bernard) Moore, comb nov.**

Basionym: *Rhizoctonia repens* Bernard, Ann. Sci. Nat. Bot., sr. 9(1909): 31.

Teleomorph: *Tulasnella calospora* (Boud.) Juel (Warcup & Talbot, 1967; Hadley, 1970).

Epulorhiza sp. *R. globularis* Saksena & Vaartaja (1960), nom. inval., belongs here because its teleomorph is a *Sebacina* sp. (Warcup & Talbot, 1966) (not *Ceratobasidium fibulatum* Tu & Kimbrough, nom. inval. (Ginns, 1983)).

MONILIOPSIS Ruhland. Arb. K. biol. Anst. 6(1908): 76.

Appearing like *Rhizoctonia*. Hyphae multinucleate; dolipore septum with perforate parenthesomes; teleomorphs *Thanatephorus* and *Waitea*. Type species: *Moniliopsis aderholdii* Ruhl. (von Arx, 1974).

***Moniliopsis oryzae* (Ryker & Gooch) Moore, comb. nov.**

Basionym: *Rhizoctonia oryzae* Ryker & Gooch, Phytopathology 28(1938): 238.

Teleomorph: *Waitea circinata* Warcup & Talbot (Oniki et al, 1985).

***Moniliopsis solani* (Kühn) Moore, comb. nov.**

Basionym: *Rhizoctonia solani* Kühn, Die Krankheiten der Kulture gewächse, Ihre ursachen und ihre Verhütung. Gustav Bosselman, Berlin, p. 224. 1858. (see Setliff et al. (1972) and Lisker et al. (1975) for ultrastructural analyses.)

=*MONILIOPSIS ADERHOLDII* Ruhland, Arb. K. Biol. Anst., Berlin 6(1908): 76.

Teleomorph: *Thanatephorus cucumeris* (Frank) Donk (Warcup & Talbot, 1967; Lisker et al., 1975; Yanxi et al., 1985).

PARMETER & WHITNEY (1970) point out that *M. solani* is a cosmopolitan, polymorphic form whose many variants "...have adapted to the numerous climate, soil, and vegetation regimes of the world ... these variants are to some degree isolated by their ecologies, leading to certain geographical and ecological discontinuities in distribution." These authors also give three sets of characters useful in identifying isolates of this species: those consistently present (multinucleate cells in somatic hyphae (see Burpee et al. 1978), dolipores, distinctive pattern of branching and septation, and brown coloration); those usually present (among which are sclerotia, wide hyphae, and

pathogenicity); and those never possessed (clamps, conidia, sclerotia composed of rind and medulla, rhizomorphs, coloration other than brown, and any teleomorph other than *Thanatephorus cucumeris*). They emphasize, however, that the final arbiter is the production of the teleomorph, *T. cucumeris* (see Tu & Kimbrough, 1975b).

Moniliopsis zeae (Voorhees) Moore, comb. nov.

Basionym: *Rhizoctonia zeae* Voorhees, Phytopathology 24(1934): 1299.

Teleomorph: *Waitea circinata* Warcup & Talbot (Oniki et al, 1985).

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ILLINOIS FUNGI XIII. **TUBAKIA DRYINA**

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SUMMARY

The nomenclatural history of the leaf-parasite **Tubakia dryina** is summarized, the fungus is illustrated with light and scanning electron microscopy, and revised host range data for Illinois are presented.

Limber and Cash (1945) presented a detailed historical review and an illustrated description of **Actinopelte dryina** (Sacc.) Hoehnel. Sutton (1973) noted that the generic name **Actinopelte** Saccardo, 1913, is a later homonym of **Actinopelte** Stizenberger, 1861, a genus of lichens. He proposed the new name **Tubakia** Sutton for **Actinopelte** Sacc. and the new combination **Tubakia dryina** (Sacc.) Sutton.

Tubakia dryina originally was described by Saccardo (1878) from living leaves of **Quercus pedunculata** Ehrh. in northern Italy as **Leptothyrium dryinum**. Its type material was issued by Saccardo in 1876 as **Mycotheca veneta** No. 555 under the name "**?Stigmella dryina** Lev." Hoehnel (1925) transferred **L. dryinum** to **Actinopelte** Sacc., restricted the application of the name to European collections, and established a new species, **A. americana**, for American collections. This later name is now considered to be a synonym of **T. dryina**. Ellis and Everhart (1888) established a new species, **Leptothyrium castanicola** based on material from **Castanea vesca** Gaertn. (= **C. sativa** Mill.). This species was considered synonymous with **T. dryina** (as **A. dryina**) in the extensive review of Limber and Cash (1945), and we concur with their opinion. Tehon

(1924) and Tehon and Stout (1929) established the following three species, each in different genera, for what appears to be **T. dryina**: **Actinothyrium gloeosporioides** Tehon, **Pirostoma nyssae** Tehon, and **Leptothyrella liquidambaris** Tehon and Stout. The type collections of **A. gloeosporioides** and **P. nyssae** are lost and we have therefore lectotypified these species herein, based on their respective original illustrations. We consider both to be conspecific with **T. dryina**. The original description and illustrations of **A. gloeosporioides** agree with our concept of **T. dryina** and is well within the species concept adopted by Limber and Cash (1945). Tehon considered **Pirostoma nyssae** distinct from **L. dryinum** because of the nature of the "pycnidium" and the olivaceous to brown, slightly verrucose conidia. These characters were observed by us to be variable even within the same collection, and we consider **P. nyssae** a synonym of **T. dryina**. In a later publication, Tehon (1948) agreed that his three species could be included in the broad description of **A. dryina** given by Limber and Cash.

Taxonomic concepts in the genus **Tubakia** were revised further by Yokoyama and Tubaki (1971), who, in a detailed study of Japanese material, described several new species and gave a detailed description of **T. dryina**. According to them the fungus produces a scutellum borne on a single columellar cell, and forms both conidia and microconidia, but within separate conidiomata. They reported the fungus to be uncommon in Japan, and stated that different collections vary in conidial size, shape, and pigmentation.

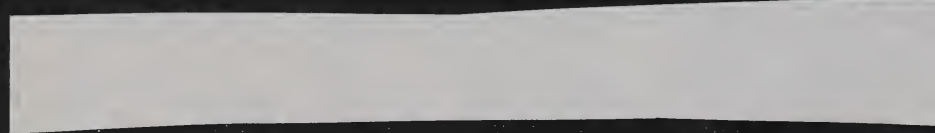
More recently, Jones and Holcomb (1978) gave an account of the morphology and cytology of two Louisiana isolates of **T. dryina** in artificial culture. Their isolates did not form microconidia, but did form conidia (comparable to the conidia described by Yokoyama and Tubaki [1971]) from percurrently proliferating conidiogenous cells. Kim and Wagner (1977) reported in an abstract that both conidia and microconidia were produced by **T. dryina** on host material in eastern USA, but did not include information on sporulation in culture.

In the present study we examined numerous collections from a variety of hosts in Illinois, as well as type or other authentic material from other regions. In addition we studied an Illinois isolate in culture. On the basis of these results we regard **T. dryina** as a somewhat variable species occurring on a wide range of hosts. While such a view is consistent with the morphological data obtained,

ERRATA, VOLUME TWENTY-NINE

Page 102 line 13 *for* L. dryinum
19 *for* A. dryina

read Leptothyrium dryinum
read Actinopelte dryina



experimental tests of the host ranges of different isolates would be helpful in determining whether the present concept of this species includes isolated, host-specific populations. Although previous authors (Limber and Cash, 1945; Yokoyama and Tubaki, 1971) described the columella of *T. dryina* conidiomata as single-celled, we have been unable to find conclusive evidence to corroborate this view. Because of the small size and fragility of the conidiomata, we were forced to examine columellar structure in paraffin sections. Observations on such material left us unconvinced that the columella should be viewed as strictly single-celled, and suggested that this character is difficult to use in separating *Tubakia* species. Developmental studies of conidiomata on host tissue may be helpful in better characterizing the structure of the columella. Like Jones and Holcomb (1978), we were unable to find microconidia, although they were reported by Yokoyama and Tubaki (1971) and Kim and Wagner (1977). It is possible that specific environmental conditions are necessary to induce production of microconidia; in any event, it appears that microconidia occur only sporadically. Our collections and cultures did resemble those of Yokoyama and Tubaki (1971) in producing ovoid conidia of requisite size range that were initially hyaline and turned brownish with age. We found conidial ontogeny to proceed similarly on host material and in culture, with conidiogenous cells proliferating percurrently to become annellate or periclinally thickened. Thus, our findings on conidial ontogeny corroborate the report of Jones and Holcomb (1978) based on cultured material.

MATERIALS AND METHODS

In order to examine conidiomatal structure, dried herbarium specimens containing conidiomata of *T. dryina* were prepared for light microscopy using standard techniques of paraffin embedment, sectioned at 12 μ m thickness, and stained with periodic acid-Schiff stain (Beneke and Rogers, 1970). Material for examination by scanning electron microscopy (SEM) was fixed 24 h in Karnovsky's fixative (Karnovsky, 1965), washed in distilled water, and mounted and oriented on aluminum stubs with transparent double-coated tape (3 M Corp., no. 666) using the technique of Vavra and Small (1969). The material then was frozen in liquid nitrogen. Next, stubs with specimens were mounted in a cool stub holder and placed in an Edwards tissue dryer at -64 C in a vacuum of 0.002 torr for

subsequent sublimation. A thin film of gold-palladium was sputter-coated onto the freeze-dried specimens for 30 sec using an SPI sputter coater (model no. 12151). The specimens then were examined with a scanning electron microscope (ISI-DS-130) at 5-10 kV accelerating voltages and photographed on positive-negative film and paper (Polaroid Corp. p/n 55) or Ektopan sheet film (Kodak Corp. no. 4162).

NOMENCLATOR

Tubakia dryina (Sacc.) Sutton, *Transactions of the British Mycological Society* 60: 165. 1973.

- ≡ **Leptothyrium dryinum** Sacc., *Michelia* 1: 202. 1878.
(basionym)
- ≡ **Actinopelte dryina** (Sacc.) Hoehnel, *Mitteilungen aus dem botanischen Institut der Technischen Hochschule in Wien* 2: 69. 1925.
- = **Leptothyrium castanicola** Ellis & Everhart, *Journal of Mycology* 4: 103. 1888.
- = **Actinothyrium gloeosporioides** Tehon, *Mycologia* 16: 136-137. 1924. Lectotype: *Mycologia* 16, Plate 13, Figs. 3-6.
- = **Pirostoma nyssae** Tehon, *Mycologia* 16: 137. 1924.
Lectotype: *Mycologia* 16, Plate 13, Figs. 7 and 8.
- = **Actinopelte americana** Hoehnel, *Mitteilungen aus dem botanischen Institut der technischen Hochschule in Wien* 2: 68. 1925.
- = **Leptothyrella liquidambaris** Tehon & Stout, *Mycologia* 21: 192. 1929. [as *Leptothyriella liquidambaris*]

OBSERVATIONS

On host material: **Conidiomata** circular, scutellate (Figs. 1, 3, 4), each attached to substrate by a hyaline central columella several cells wide (Figs. 5, 6); upper surface (Figs. 1, 4) prosenchymatous, composed of brown, rather thick-walled hyphae which radiate from the center branching repeatedly, with acute ends, forming a fringed edge unattached to the substrate, (44-)78-126(-136) μm diam. **Conidiogenous cells** radiating outward from columellar region, (Figs. 5, 6) cylindrical to somewhat lageniform (Figs. 8, 9), sometimes with a distinct collarette (Fig. 7), proliferating to become percurrently thickened or annellate, bearing conidia in densely packed masses beneath scutellum (Fig. 2), hyaline, (5-)6-7(-7.5) $\times$

2.5-3(-4) μm . **Conidia** (Figs. 10, 11) ovoid, smooth to finely echinulate, often with basal frill or protuberant hilum, initially hyaline, becoming somewhat brownish with age, 8-14(-16) X (4-)6-10(-12) μm .

In culture: **Colonies** on Difco potato dextrose agar white, rather felty, forming concentric olivaceous rings due to production of abundant conidia. Forming conidia in 2-5 days. **Conidiogenous cells** either borne in sporodochium-like aggregations (Fig. 12), or directly on hyphae (Fig. 13), short cylindrical, often somewhat attenuated near apices, proliferating percurrently to form periclinal thickenings (Fig. 14) or annellations (Figs. 15, 16), hyaline to brownish, (6-)8-12.8(-14.4) X 4-5.6(-9.6) μm . **Conidia** single-celled, ovoid, with densely granular cytoplasm (Fig. 17), bases truncate or with protuberant hilum, brownish, 12-16(-17.4) X (6-)7.2-8.8(-9.2) μm .

Material examined:

ISOTYPE: as ?*Stigmella dryina* Lev., Bosco Montello (Treviso), in pag. super. foliorum *Quercus pedunculatae*, IX.1875, in Saccardo, *Mycotheca Veneta* No. 555. Anno 1876 (PAD).

On *Acer saccharum* Marsh, Ozark, Johnson Co., Illinois, 18.VII.1931, **Leg.** G. H. Boewe, ILLS 29747. Bald Knob, Union Co., Illinois, 13.VI.1927, **Leg.** G. L. Stout, ILLS 29734. White City, Macoupin co., Illinois, 30.VIII.1937, **Leg.** G. H. Boewe, ILLS 29742. Carbondale, Jackson Co., Illinois, 29.VII.1938, **Leg.** G. H. Boewe, ILLS 29733. Buncombe, Johnson Co., Illinois, 5.VIII.1922, **Leg.** P. A. Young, ILLS 29732. Kinderhook, Pike Co., Illinois, 28.VI.1944, **Leg.** G. H. Boewe, ILLS 30074.

On *Carya ovata* (Mill.) K. Koch, Simpson, Johnson Co., Illinois, 19.VII.1929, **Leg.** G. L. Stout, ILLS 29746.

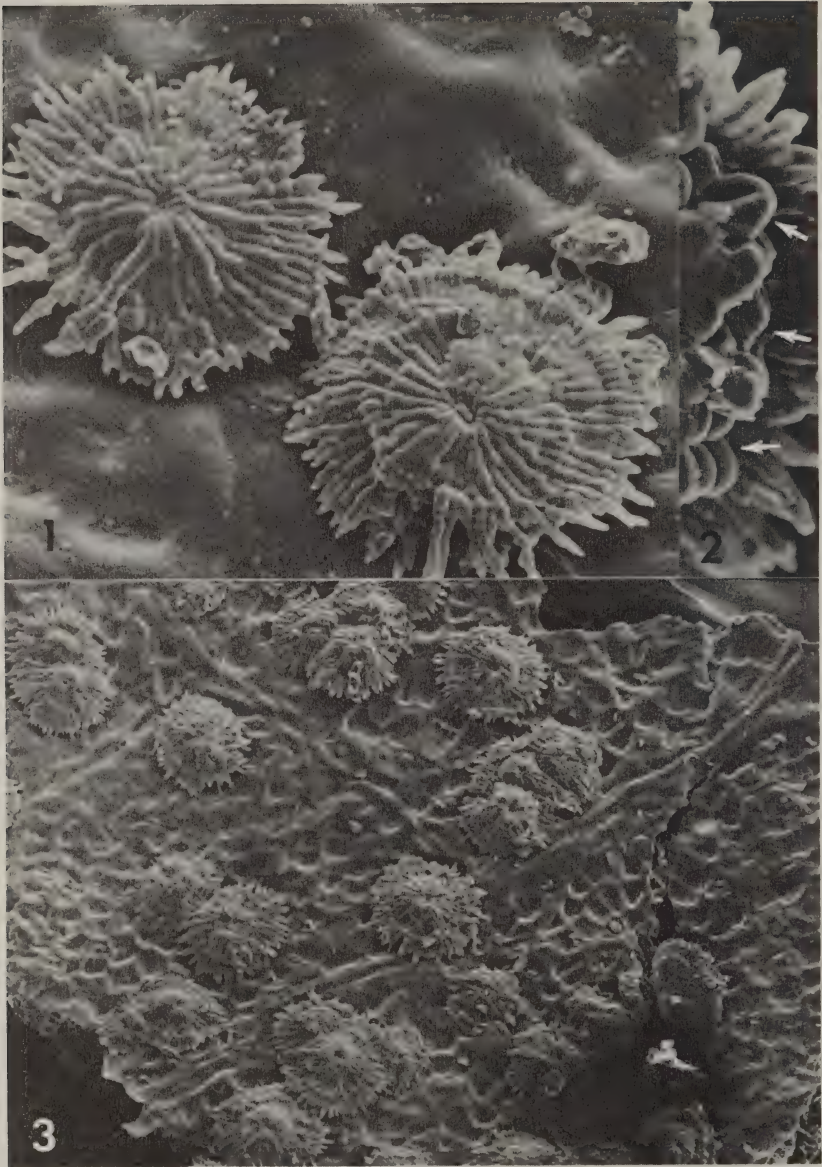
On *Castanea* sp., as *Leptothyrium castanicola* E. & E., Newfield, New Jersey, 29.X.1888 (NY), presumed HOLOTYPE of *Leptothyrium castanicola* E. & E. (sterile).

On *Castanea sativa* Mill., as *Leptothyrium castanicola* E. & E., on living chestnut leaves, Newfield, Gloucester Co., New Jersey, VIII.1894 in Ellis and Everhart, North American Fungi Cent. 32, No. 3168. Anno 1894 (ILL).

On *Castanea vesca*, as *Leptothyrium castanicola* E. & E., on leaving leaves, Newfield, Gloucester Co., New Jersey, VIII.1894 in Ellis and Everhart, *Fungi Columbiani* Cent. 8, No. 782. Anno 1895 (ILL).

On *Cercis canadensis* L., Mounds, Pulaski Co., Illinois, 10.VIII.1926, **Leg.** G. L. Stout, ILLS 29737.

On *Fraxinus americana* L., Balcom, Union Co., Illinois,



Figs. 1-3. *Tubakia dryina* on host material. 1. Two conidiomata on leaf surface, X520. 2. Underside of conidioma, arrows designate closely packed conidia, X900. 3. Conidiomata on leaf, X130.



Figs. 4-11. *Tubakia dryina* from host material. 4. Conidioma, X250. 5, 6. Longitudinal sections through conidiomata, arrows designate conidia still attached to conidiogenous cells, X1000. 7. Conidiogenous cells, one with collarette (arrow), X2500. 8. Conidiogenous cell with periclinal thickening at conidiogenous locus (arrow), X2500. 9. Conidiogenous cell with developing conidium, X2500. 10. Finely echinulate conidium with basal frill (arrow) representing site of previous attachment to conidiogenous cell, X2500. 11. Smooth conidium, with basal frill similar to that in the previous figure, X2500.



Figs. 12-17. *Tubakia dryina* from artificial culture. 12. Sporodochium-like mass of conidiogenous cells and conidia, X1000. 13. Conidiogenous cell with developing conidium, on free hypha. 14. Conidiogenous cell with periclinal thickening at conidiogenous locus (arrow), and developing conidium. 15, 16. Conidiogenous cells with annellations (arrows) indicative of percurrent proliferation. 17. Conidia. All X2500 unless otherwise noted.

11.VIII.1934, **Leg.** G. H. Boewe, ILLS 29744. Eagle Mountain, Saline Co., Illinois, 14.VII.1922, **Leg.** P. A. Young, ILLS 29741. Dongola, Union Co., Illinois, 10.VIII.1929, **Leg.** G. L. Stout, ILLS 29736.

On **Fraxinus nigra** Marsh., Boskydell, Jackson Co., Illinois, 23.VII.1923, **Leg.** P. A. Young, ILLS 5562.

On **Fraxinus profunda** (Bush) Bush, Dongola, Union Co., Illinois, 11.VIII.1927, **Leg.** G. L. Stout, ILLS 29738.

On **Liquidambar styraciflua** L., Elizabethtown, Harden Co., Illinois, 17.VI.1927, **Leg.** G. L. Stout, ILLS 29743. As **Leptothyriella liquidambaris** Tehon & Stout, Olmstead, Pulaski Co., Illinois, 9.VIII.1922, **Leg.** P. A. Young, ILLS 1445 (HOLOTYPE).

On **Nyssa sylvatica** Marsh., Bull Run Mt., Fauquier Co., Virginia, 14.VIII.1939, **Leg.** H. A. Allard No. 7246, Ex BPI 71129, ILLS 41874. Dongola, Union Co., Illinois, 12.VIII.1922, **Leg.** P. A. Young, ILLS 8871. Tunnell Hill, Johnson Co., Illinois, 25.VII.1922, **Leg.** P. A. Young, ILLS 2940.

On **Quercus** sp., Urbana, Champaign Co., Illinois, VIII.1985, **Leg.** D. Neely, ILLS 45679, COLLECTION FROM WHICH CULTURE WAS DERIVED. Ranault, Monroe Co., Illinois, 20.VII.1923, **Leg.** P. A. Young, ILLS 10221. Boskeydell, Jackson Co., Illinois, 23.VII.1923, **Leg.** P. A. Young, ILLS 6423. Golconda, Pope Co., Illinois, 28.VI.1922, **Leg.** P. A. Young, ILLS 1000. Pulaski Co., Illinois, 9.VIII.1922, **Leg.** P. A. Young, ILLS 8553. Reevesville, Johnson Co, Illinois, 27.VII.1922, **Leg.** P. A. Young, ILLS 1833. Mounds, Pulaski Co., Illinois, 10.VIII.1926, **Leg.** G. L. Stout, ILLS 3223. Makanda, Jackson Co., Illinois, 18.VIII.1922, **Leg.** P. A. Young, ILLS 11134. Dongola, Union Co., 12.VIII.1922, **Leg.** P. A. Young, ILLS 995. Tunnell Hill, Johnson Co., Illinois, 25.VII.1922, **Leg.** P. A. Young, ILLS 2925. Urbana, Champaign Co., Illinois, IX.1979, **Leg.** S. Cline, ILLS 39428; 9.IX.1979, M. N. Cline, ILLS 39458.

On **Quercus alba** L., Albion, Edwards Co., Illinois, 13.VI.1944, **Leg.** G. H. Boewe, ILLS 30073. Fox River Grove, McHenry Co., Illinois, 31.VII.1957, **Leg.** D. Neely, ILLS 32521.

On **Quercus bicolor** Willd., Fountain Bluff, Jackson Co., Illinois, 20.VI.1924, **Leg.** P. A. Young, ILLS 16125.

On **Quercus coccinea** Muenchk., as **Leptothyrium dryinum** Sacc., on living leaves, Gloucester Co., New Jersey, IX.1881, in Ellis and Everhart, North American Fungi Cent. 8, No. 732. Anno 1882 (ILL). VIII.1883, in Ellis and Everhart, **Fungi Columbiani** Cent. 3, No. 286, Anno 1884 (ILL).

On *Quercus falcata* Michx., Dixon Springs, Pope Co., Illinois, 13.VIII.1958, **Leg.** D. Neely, ILLS 32849.

On *Quercus imbricaria* Michx., Salem, Marion Co., Illinois, 13.VIII.1926, **Leg.** G. L. Stout, ILLS 29751. Mt. Erie, Wayne Co., Illinois, 5.VIII.1963, **Leg.** J. L. Forsberg, ILLS 34397. Kinmundy, Marion Co., Illinois, 14.VI.1922, **Leg.** P. A. Young, ILLS 29752. Red Bud, Randolph Co., Illinois, 24.VIII.1926, **Leg.** G. L. Stout, ILLS 29753. Balcom, Union Co., Illinois, 28.VIII.1947, **Leg.** G. H. Boewe, ILLS 33030. Thomsonville, Franklin Co., Illinois, 21.VII.1922, **Leg.** P. A. Young, ILLS 9662. West Union, Clark Co., Illinois, 27.IX.1930, **Leg.** G. H. Boewe, ILLS 29750.

On *Quercus macrocarpa* Michx., Oregon, Ogle Co., Illinois, 5.IX.1957, **Leg.** D. Neely, ILLS 32518.

On *Quercus marilandica* Muench., Pinckneyville, Perry Co., Illinois, 27.X.1926, **Leg.** G. L. Stout, ILLS 29754. Dixon Springs, Pope Co., Illinois, 13.VIII.1958, **Leg.** D. Neely, ILLS 32841, 32836. Flora, Clay Co., Illinois, 23.VII.1927, **Leg.** G. L. Stout, ILLS 29755. Edwardsville, Madison Co., Illinois, 15.VI.1944, **Leg.** G. H. Boewe, ILLS 30075.

On *Quercus palustris* Muench., Makanda, Jackson Co., Illinois, 19.VIII.1922, **Leg.** P. A. Young, ILLS 29757. Hagertown, Fayette Co., Illinois, 1.IX.1944, **Leg.** G. H. Boewe, ILLS 30127. Reevesville, Johnson Co., Illinois, 27.VII.1922, **Leg.** P. A. Young, ILLS 29756. Havana, Mason Co., Illinois, 23.VIII.1968, ILLS 35027. West Union, Clark Co., Illinois, 27.IX.1930, **Leg.** G. H. Boewe, ILLS 29735.

On *Quercus pseudorubrae* Ber. Aut. 1878, Coneglians, Benetia, **Leg.** C. Spegazzini, in de Thuemen, *Mycotheca Universalis* Cent. 16, No. 1584. Anno. 1880 (ILL).

On *Quercus robur* L. [as sur les feuilles vivantes du chene pedoncule, automne, Parc du Casino de Luchon, Hte-Garonne (Pyren. -Cent.)] **Leg.** C. Foucade in C. Roumeguere, *Fungi selectis exsiccatis* Cent. 52, No. 5172. Anno 1890 (ILL).

On *Quercus rubra* L., Seymour, Champaign Co., Illinois, 15.X.1925, **Leg.** E. Daniels, ILLS 9282. Fountain Bluff, Jackson Co., Illinois, 20.VI.1924, **Leg.** P. A. Young, ILLS 5541. Urbana, Champaign Co., Illinois, X.1979, **Leg.** C. C. Yeh, ILLS 39317. Washington, D. C., 27.IX.1949, **Leg.** C. May, ILLS 30871.

On *Quercus shumardii* Buckley, Pope Co., Illinois, 3.VIII.1922, **Leg.** P. A. Young, ILLS 11752.

On *Quercus stellata* Wang., Lusk, Pope Co., Illinois, 16.VI.1927, **Leg.** G. L. Stout, ILLS 29758.

On *Quercus velutina* Lam., Fox River Grove, McHenry

Co., Illinois, 31.VII.1957, **Leg.** D. Neely, ILLS 32517.

On **Rhus radicans** L., Sandoval, Marion Co., Illinois, 6.VI.1944, **Leg.** G. H. Boewe, ILLS 30072.

On **Sassafras albidum** (Nutt.) Nees, Fountain Bluff, Jackson Co., Illinois, 20.VI.1924, **Leg.** P. A. Young, ILLS 17547. Mounds, Pulaski Co., Illinois, 10.VIII.1926, **Leg.** G. L. Stout, ILLS 29748. Salem, Marion Co., Illinois, 13.VIII.1926, **Leg.** G. L. Stout, ILLS 29745.

On **Ulmus alata** Michx., Goreville, Johnson Co., Illinois, 22.VI.1924, **Leg.** P. A. Young, ILLS 12867, 12804. Sanburn, Johnson Co., Illinois, 15.VI.1927, **Leg.** G. L. Stout, ILLS 29740.

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THE XYLARIACEAE OF THE RAIN FORESTS OF NORTH SULAWESI (INDONESIA)

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ABSTRACT

A treatment of the Xylariaceae of the rain forests of the Dumoga-Bone National Park, Sulawesi, is presented here. Sixty taxa are treated, including 27 of Xylaria, 18 of Hypoxylon, 7 of Penzigia, 5 of Kretzschmaria, and one each of Daldinia, Entonaema, and Rosellinia. Hypoxylon maculosum sp. nov., Kretzschmaria intracolorata sp. nov., Xylaria angulosa sp. nov., and Xylaria hypsipoda var. microspora var. nov. are proposed.

A key to genera and keys to species of individual genera are provided.

This paper is the first of a projected series of papers describing the fungi collected in North Sulawesi (formerly the Celebes), Indonesia. Samuels was a participant in an expedition known as Project Wallace that was jointly supported by the Royal Entomological Society (London) and the Indonesian Institute of Sciences. The project ran for the entire year of 1985; Samuels participated in the expedition for six weeks from late September. The expedition was located in the northern peninsula of Sulawesi a little under 1° north of the Equator within the catchment area of the Dumoga and Bone Rivers. The area has recently been designated as the Dumoga-Bone National Park. It is entirely landlocked; more than 90% of the

approximately 280,000 ha park is occupied by undisturbed primary lowland and lower montane rain forest between 300 and 1600 m. Rainfall in the area is apparently uniform throughout the year. Most collections were made near the confluence of the Toraut and Tumpah Rivers at an elevation of ca. 200 m but several excursions were made along ridges that lead to elevations of approximately 1800 m (Gn. Poniki), 1400 m (Danau Alia) and 1100 m. An attempt was made to sample a wide variety of vegetation types at various elevations. No mycological or botanical exploration has previously been undertaken in the area.

It is perhaps premature to comment on the numbers and distributions of Xylariaceae on the basis of one expedition. However, several points seem noteworthy. First, many of the taxa recorded are represented by only one collection, indicating that most individual taxa are not truly abundant. This might be a reflection of the host plant distributions and mixtures. Second, it was most surprising to encounter only one species of Rosellinia and this only one time. Rosellinia species are common components of rain forests in various parts of the world and their paucity in the collecting area is unexplained. Third, the area in question seems devoid of Camillea species and applanate Hypoxylon species that would probably best be placed in Camillea. It is our overall impression that xylariaceous fungi of North Sulawesi are not common in terms of taxa or frequency of individual taxa as compared with islands associated with southern North America, Central America or South America. Indeed, this might be true were the entire Indonesian archipelago compared with the above areas and land masses. In any case, fungal biogeography is generally in its infancy and more soundly based and broad conclusions await many more data and analyses of data.

MATERIALS AND METHODS

Parts of each collection were air-dried, where possible, in anticipation of cultural studies. Cultures were attempted from favorable material by streaking ascospores onto agar media. Single germinated ascospores or masses were transferred to various agar growth media (note in culture descriptions). Cultural features and anamorphs, where produced, were characterized.

Herbarium cited as JDR is the personal collection of J. D. Rogers.

Key to Genera Treated

1. Stromata usually upright on short or long stipes. 2
1. Stromata usually not stipitate, but sessile
or on narrowed connectives 3
 2. Stromata usually cylindrical or clavate,
usually taller than the greatest stromatal
diameter. Xylaria
 2. Stromata usually convex or nail-shaped,
the diameter of the disc usually exceeding
stromatal height. Often aggregated in
crusts Kretzschmaria
(see also Penzigia)
3. Stromata appearing as individual perithecia,
the stromata often embedded in, or associated
with, a subiculum Rosellinia
3. Stromata containing several to many perithecia. . . 4
 4. Stromata more or less subglobose and
filled with liquid when fresh, becoming
hollow. Flesh lining cavity gelatinous
when wet, drying horny-hard Entonaema
 4. Stromata various shapes, but never filled
with liquid. Some becoming hollow, but
not notably gelatinous when wet. 5
5. Stromata subglobose to hemispherical, the
interior appearing as concentric rings . . . Daldinia
5. Stromata hemispherical, pulvinate, applanate,
or irregular, the interior not appearing
as concentric rings 6
 6. Stromata usually with dark flesh or,
if white, soon disintegrating, black-
ening, or becoming obliterated by
expanding perithecia Hypoxylon
 6. Stromata usually with white flesh
which persists or slowly disintegrates.
Most species are sessile forms of
Xylaria or are otherwise little dif-
ferent from Hypoxylon Penzigia

Daldinia, Entonaema, and Hypoxylon*

1. Stromata sulfur yellow, bladder-like, filled with liquid when fresh and hollow when dry. Ascospores 7-10.5 X 5-6.5 μm Entonaema liquescens
1. Stromata of various colors, neither bladder-like nor filled with liquid, but solid (stromata of a few species become hollow with age). 2
 2. Stromata more or less hemispherical, stipitate or sessile, the interior composed of concentric rings of tissue Daldinia cf. eschscholzii
 2. Stromata of various shapes, the interior not composed of concentric rings of tissue (Hypoxylon spp.) 3
3. Perithecial ostioles papillate in a flattened disc (section Annulata). 4
3. Perithecial ostioles papillate or umbilicate, not usually associated with an annulate disc. . . . 6
 4. Ostiolar disc minute, 0.1-0.2 mm in diameter. Ascospores 5-7.5 X 2-3.7 μm Hypoxylon stygium
 4. Ostiolar disc larger, 0.3 mm or more in diameter. Ascospores of various sizes. 5
5. Ostiolar disc 0.5 mm or more in diameter. Ascospores 7-8 X 3-3.7 μm Hypoxylon bovei var. microspora
5. Ostiolar disc 0.3 mm in diameter. Ascospores 11-13.5 X 6-6.5 μm Hypoxylon sp. (2404)
 6. Stromata applanate (section Applanata). 7
 6. Stromata of various shapes, but not consistently applanate. 9
7. Ascospores one-celled (17.5-)20.5-24 X (6-)6.5-7.5(-10.3) μm . Stromata widespreading X 1 mm or less thick, with inconspicuous umbilicate ostioles. Dull black mottled white. . . . Hypoxylon maculosum sp. nov.
7. Ascospores with hyaline cellular (primary) appendage or with obviously truncate end

* The single Rosellinia species is not incorporated in this key, but is included among descriptions of taxa.

- following loss of appendage. Stromata 1 mm thick or less with very inconspicuous papillate to more or less umbilicate ostioles. Dull black. 8
8. Ascospores (including appendage) 9.5-10.5 X 4.5-6 μm Hypoxylon uniapiculatum
8. Ascospores (including appendage) 17.5-22 X 8.8-11.8 μm
. Hypoxylon uniapiculatum var. macrosporum
9. Stromata usually pulvinate, sometimes brightly colored when young, but usually blackish when mature. Ostioles papillate (section Papillata). . 10
9. Stromata usually pulvinate to hemispherical, often brightly colored at maturity. Ostioles umbilicate (section Hypoxylon). 13
10. Stromata pulvinate, massive, up to 7 mm thick, dark wine-colored. Ostioles punctate to slightly papillate, each surrounded by a raised margin, the interconnected margins forming conspicuous surface ornamentation. Ascospores 11.5-14 X 4.5-6 μm , frequently misshapen
. Hypoxylon rubigineo-areolatum
10. Stromata pulvinate, thick or thin, but lacking the combination of characters above. 11
11. Stromata pulvinate, 1-2 mm diameter, greyish to lilac. Ostioles slightly raised, inconspicuous. Ascospores 25-31 X 7-9 μm , often with conspicuous flaring noncellular (secondary) appendages. Hypoxylon nummularioides
11. Stromata pulvinate, much larger in diameter and/or thickness. Ascospores much smaller or much larger. 12
12. Stromata pulvinate, ca. 1 cm diameter X less than 1 mm thick, dull black. Ostioles finely papillate. Ascospores 7-9.5 X 3-3.8 μm
. Hypoxylon cf. investiens
12. Stromata loaf-shaped to hemispherical, about 7 mm high, yellowish. Perithecia very large, 2-3 mm diameter; ostioles obscure. Ascospores 91-114 X 30-43 μm
. Hypoxylon sp. (2293)

13. Perithecial contours usually evident to conspicuous, the individual perithecia sometimes appearing to be completely free or naked (see also description of Rosellinia necatrix). 14
13. Perithecial contours usually not evident, the individual perithecia embedded in the stroma. 15
14. Perithecial contours very conspicuous, united in widespreading aggregations. Greyish to cocoa brown, sometimes with yellow granules beneath surface. Ascospores $11.5-12 \times (4.5-5-6 \mu\text{m})$ Hypoxylon cf. oodes
14. Perithecial contours very conspicuous, united in small aggregations 1-3 mm diameter. Dull brown with sulfur yellow granules just beneath surface. Ascospores $(14.7-17.6-22(-23.5) \times (6.5-7-9(-10) \mu\text{m})$, appearing ornamented with low reticulations or shallow pits. Hypoxylon rubellum
15. Stromata usually lacking bright colored granules just beneath surface. 16
15. Stromata usually with yellow, orange, or red granules just beneath surface. 17
16. Stromata pulvinate, widespreading $\times 2 \text{ cm}$ thick, reddish. Ascospores $10-12 \times 4.5 \mu\text{m}$, frequently misshapen. Hypoxylon sclerophaeum
16. Stromata pulvinate, discrete or widespreading, seldom exceeding 1 mm in thickness, reddish brown. Ascospores $7-8(-9) \times 3.7-4.4 \mu\text{m}$ Hypoxylon rubiginosum var. dieckmannii
17. Stromata dull reddish brown with yellow granules immediately beneath surface. Ascospores $(10-11-12 \times 4.5-6 \mu\text{m})$, with conspicuous dehiscent hyaline external wall (perispore). Hypoxylon rubiginosum complex
17. Stromata reddish or brown with reddish tones, with orange or red granules immediately beneath surface. 18
18. Stromata bright orange red with orange granules immediately beneath surface.

- Ascospores 13-17.5 X 6-8 μm , with conspicuous dehiscent hyaline external wall (perispore). Hypoxyton crocopeplum
18. Stromata lacking bright orange surface color. Ascospores smaller. 19
19. Stromata rusty red with orange red granules immediately beneath surface. Ascospores 8-9.5 X 3.5-4.5 μm , with conspicuous dehiscent hyaline external wall (perispore) Hypoxyton jecorinum
19. Stromata brown with red tones to wine-colored with orange granules just beneath surface. Ascospores 8-10.3 X 4.5-5 μm , with conspicuous dehiscent hyaline external wall (perispore). Hypoxyton hypomiltum

Kretzschmaria

1. Fertile parts flat-topped to convex on warty stipes, 2-4 mm X 2-4 mm diameter, black with bright yellow to orange granules just beneath the surface, the interior otherwise white. Ostioles papillate. Ascospores (8.8-)10-12 X 4.4-5 μm , with long germ slit Kretzschmaria intracolorata sp. nov.
1. Fertile parts similar in shape and size, black, but lacking bright colored granules beneath surface, often becoming hollow with age. Ostioles papillate. Ascospores various. . . .2
2. Ascospores much shorter than 20 μm 3
2. Ascospores 20 μm or longer. 4
3. Fertile parts convex on narrow stipes, 2-3 mm X 2-3 mm diameter, roughened by warts and cracking. Ascospores 9-10 X 5-6 μm , with inconspicuous long germ slit . . Kretzschmaria heliscus
3. Fertile parts nail-shaped on narrow stipes, 1-2 mm X 2-3 mm diameter, aggregated into crusts. Ostiolar papillae in flattened discs. Ascospores 9-11 X 3.7-4.4 μm , with germ slit less than spore-length. Kretzschmaria cf. microspora
4. Fertile parts nail-shaped on short stout stipes, 2 mm X 4 mm diameter, the surface deeply cracked, black with white patches. Ostioles obscure. Ascospores (19-)20.6-

- 25 X 6.6-8 μm , with short spiralling germ slit. Kretzschmaria cf. mauritanica
4. Fertile parts convex on short to long stipes, 2-7 mm X 2-4 mm diameter, dull brownish black to black. Ostioles finely papillate. Ascospores 31-39 X (6.6-) 7.3-9.5 μm , with germ slit slightly less than spore-length Kretzschmaria clavus

Penzigioid fungi

1. Stromata with external coloration other than (or in addition to) dark grey, brown, or black . . .2
1. Stromata with external coloration of dull grey, brown, or black. 4
2. Stromata hemispherical or on narrow connective, up to 6 mm diameter, orange-brown with dark lines or furrows. Ostioles papillate. Ascospores 23-26.5 X 7.3-8 μm , with abrupt, narrowed to acute ends, with germ slit greatly less than spore-length
 Penzigia sp. (2132)
2. Stromata convex to globose, of various size ranges, predominately yellowish white to white. 3
3. Stromata subglobose on narrow connective, 2.5 cm diameter, yellowish white, the interior flesh at first white, becoming hollow. Ostioles umbilicate. Ascospores 24-30 X 8-9.5(-10.3) μm , with germ slit slightly or greatly less than spore-length.
 Penzigia cranioides
3. Stromata convex on narrow stipe, 2-3 mm X 3 mm diameter, roughened by raised punctate ostioles, white with rusty orange blotches. Ascospores 29.4-35.3 X (11.8-)17.6-20.6 μm , with long slit. Penzigia macrospora
4. Ascospores not exceeding 24 μm in length 5
4. Ascospores over 30 μm in length. 6
5. Stromata pulvinate to hemispherical, 2 mm diameter, the surface finely cracked, greyish black. Ostioles papillate. Ascospores

- 17.6-22 X 7.3-9 μm , with short undulate to sigmoid germ slit Penzigia cf. atrosphaerica
5. Stromata hemispherical to irregular, on abrupt narrow stipes, 2-3 mm X 7 mm diameter, surface smooth, black. Ostioles finely papillate. Ascospores 20.6-23.5 X 6.6-7.3 μm , with short oblique germ slit Hypoxydon cf. cadigensis
6. Stromata globose to irregular on narrow base, 5-10 mm diameter, the surface minutely warty, black; interior flesh white, disintegrating. Ostioles raised, punctate. Ascospores 31-37 X 6-7.3 μm , fusoid to crescentic, with short germ slit Penzigia sp. (2461, 2378)
6. Stromata pulvinate to hemispherical on narrow connective, 1.3 cm diameter, black. Ostioles punctate, obscure. Ascospores 37-44 X 16-19 μm , more or less rectangular to irregular, with long spiralling germ slit. Penzigia sp. (2418)

Xylaria - Species with large stromata on wood

1. Stromatal surfaces more or less smooth, usually tan, orange, white, or grey until blackening with age. 2
1. Stromatal surfaces more or less roughened with perithecial contours, coarse ostiolar papillae, warts, or wrinkles or all of the above, usually more or less black at maturity. 5
2. Fertile part clavate to fusoid on short stipe, up to 12 cm X 2.5 cm diameter, greyish and mottled with tan, yellow, or black and with darker longitudinal stripes. Ostioles umbilicate. Ascospores (10.3-) 11.7-14 X (4-)4.5-5(-6) μm . . . Xylaria grammica
2. Not with above combination of characters and, particularly, lacking longitudinal stripes. 3
3. Fertile part clavate on short stipe, up to 4 cm X 1.2 cm diameter, tan to dark brown. Ostioles finely papillate. Ascospores 8-9(-9.5) X 3.7-4.4 μm Xylaria cubensis

3. Fertile parts various. Ostioles truly umbilicate. Ascospores much larger. 4
4. Fertile parts clavate to subglobose on short or long stipe, up to 6 cm X 1.5 cm diameter, chalk white to greyish white, often mottled with yellow or orange, with black ostioles. Interior flesh at first white, becoming dull black. Ascospores 26-32.5 X (6-)6.6-7.3 μm with acute ends and short straight germ slit
. Xylaria dealbata
4. Fertile parts cylindrical to fusoid on short stipe, up to at least 6 cm X 1.5 cm diameter, light orange or tan. Becoming hollow and inrolled early, often before maturation of perithecia. Ascospores 16-19 X 6.6-7.3 μm , with rounded or pinched ends and short oblique germ slit Xylaria telfairii
5. Stromata highly variable in shape, clavate to spatulate to highly irregular on short or long stipes, up to 4 cm X 1.5 cm diameter, dull black. Ascospores 23-30 X (6.6-) 7.3-9 μm , with short, oblique germ slit
. Xylaria anisopleura
5. Stromata highly variable in shape, cylindrical to clavate to highly irregular, on short or long stipes, up to 14 cm (most 7 cm or less) X 1.5 cm, dull black. Ascospores (16-)17.6-23(-25) X 6-9 μm , with short, oblique to curving germ slit.
. Xylaria scruposa

Xylaria - Taxa with small stromata on wood

1. Fertile part subglobose to globose on hairy stipe, up to 2 cm X 3 mm diameter, dull black at maturity but yellow when immature. Ascospores 23-26.5 X 7.3-9 μm Xylaria sp. (2454)
1. Fertile parts of various shapes, but not globose. Other characters various. 2
2. Fertile part cylindrical to long conical, on long thin stipe. 3
2. Fertile part cylindrical to clavate or otherwise, usually on short stipe 5

3. Fertile part cylindric-clavate on thin stipe, often cespitose, up to 3 cm X 3 mm diameter, with wrinkled surface, black. Ascospores (13-)14-16 X 4.4-6 μm Xylaria cf. berkeleyi
3. Fertile part cylindrical to long conical on long hairy stipe 4
4. Fertile part blackish with remnants of grey or whitish shredding layer. Ascospores 11.7-14.7 X 4.4-5 μm Xylaria arbuscula
4. Fertile part as above. Ascospores 14.7-18.4 X (4.4-)6-6.6 μm Xylaria apiculata
5. Fertile part broadly clavate, sessile or on very short stipe, surface conspicuously roughened and cracked, black. Ascospores 20.6-25(-25.7) X 6-8.8 μm , with short spiralling slits Xylaria clavus
5. Fertile parts cylindrical to narrowly clavate, sessile or on short stipes. Other characters or combinations of characters not as above. 6
6. Interior flesh other than white. Stromata usually becoming hollow. 7
6. Interior flesh white. Stromata usually remaining solid. 8
7. Fertile part up to 5 cm X 2-5 mm diameter, wrinkled and warty, with prominent ostioles, dull black with bright orange interior, often becoming hollow with age. Cespitose. Ascospores 8.8-10.3 X 4.4-5 μm Xylaria luteostromata
7. Fertile part up to 2.5 cm X 2 mm diameter, dull black with interior tan surrounding perithecia and black at center, soon becoming hollow and inrolled. Cespitose. Ascospores 13.3-14.7 X 4.4-5 μm Xylaria fissilis
8. Fertile part 4 cm X 2-3 mm diameter, roughened from ostioles and deep cracks, dull blackish brown. Ascospores 8-9.5 X 3.7-4.4 μm Xylaria aff. feejeensis
8. Fertile part 5 mm X 1.5-3 mm diameter, roughened from ostioles, perithecial elevations, wrinkles, and warts, blackish.

Ascospores 6-7.3 X 3-3.7(-4.4) μm
 Xylaria beccarii

Xylaria - Species on monocots*

1. Fertile part consisting of clustered naked perithecia on short hairy rachis which sometimes extends beyond them, ca. 5 mm long X 2 mm diameter, black. Ascospores 16-17.6 X 6-7.3 μm , with short straight to oblique germ slit.
 Xylaria cf. copelandii
1. Fertile parts consisting of more or less clustered naked perithecia on long stipes, blackish. Ascospores various. 2
2. Fertile part up to 3 cm X 1-1.5 mm diameter, both clava and stipe hairy. Ascospores 16-17.6 X 6-6.6 μm , the ends abrupt and pinched, with germ slit slightly less than full-length
 Xylaria juruensis
2. Fertile part up to 6 cm X 3 mm diameter, both clava and stipe tomentose. Ascospores 14.7-17.6 X 5-6 μm , the ends rounded to acute, with germ slit slightly less than full-length
 Xylaria sp. (2386, 2405)

Xylaria - Species on leaves

1. Fertile parts of stromata subglobose to globose with perithecia completely immersed. 2
1. Fertile parts of stromata composed of scattered or aggregated naked perithecia. 3
2. Fertile part less than 1 mm diameter, on fine stipe up to 1 cm long, brown. Ascospores 8-9(-9.5) X 4.4-5(-6.6) μm
 Xylaria hypsipoda var. microspora var. nov.
2. Fertile part up to 3 mm diameter, on fine stipe up to 3 cm long, brown. Ascospores 14-16(-17.6) X (6-)7-8 μm
 Xylaria hypsipoda

* It is possible that some of these taxa also occur on dicots.

3. Fertile part a 1 mm long aggregation of perithecia on hair-like rachis up to 6 mm long, dull black. Ascospores 8-9.5 X (4.4-) 5-6 μm , with a noncellular (secondary) appendage on each end
 Xylaria taxonomic species 1 (2310)
3. Fertile parts and stipes longer. 4
4. Fertile part an aggregation of perithecia or scattered perithecia on a rachis up to 2 cm long, black. Ascospores 9-10.3 X 4.4-5 μm , with a noncellular (secondary) appendage at each end.
 Xylaria taxonomic species 2 (2055)
4. Fertile part an aggregation of perithecia 3 mm long near middle of rachis 1.5 cm long, black. Ascospores 11.7-13 X 4.4-5 μm , with an inconspicuous noncellular (secondary) appendage at each end.
 Xylaria taxonomic species 3 (2168)

Xylaria - On soil or insect nests

1. Fertile part cylindric-clavate with abrupt long stipe, up to 8 cm X 4 mm diameter. Ascospores 8-9.5 X 3.6-4.4 μm
 Xylaria sp. (2304)
1. Fertile parts usually cylindrical, with long stipes. Ascospores not usually longer than 6 μm 2
2. Ascospores 3.6-4.4 X 2.2-3 μm , with lateral pore-like germination site
 Xylaria cf. melanaxis
2. Ascospores 4.4-5.9 X 2.2-3 μm , with conspicuous long germ slit. 3
3. Fertile part cylindrical on long stipe and rooting process, up to 15 cm X 5 mm, yellowish, grey, or dull black. Xylaria nigripes
3. Fertile part cylindrical, often with branches at obtuse angles (Thamnomycetes-like), up to 12 cm X 3 mm diam, dull black
 Xylaria angulosa sp. nov.

Daldinia cf. eschscholzii (Ehrenb.) Rehm, Ann. Mycol.
2: 175. 1904.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on log, Samuels 1939, Sep-Oct 1985 (NY,BO); same data, Samuels 2035, 2052 (NT,BO); Dumoga-Bone National Park, Amadi Hot Springs, vic. Maleo bird nesting site, in old banana plantings, on wood, Samuels 2330, Oct 1985 (NY,BO,JDR).

NOTES: Our material looks much like D. eschscholzii except that the interior rings are gray rather than brown as described by Child (1932) and Petrini & Muller (1986). Ascospores were 10.3-11.8 X 5-5.9 μm , close to the dimensions given by Child (1932) but smaller than those given by Petrini & Muller (1986). Unfortunately, we were unable to obtain cultures from our material. Cultures of the fungus are characteristic, particularly in their distinctive odor (Petrini & Muller, 1986).

Entonaema liquescens Moell., Phycomyc. Ascomyc. Bras., p. 306. 1901.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'N; elev. 211 m, on base of standing dead tree, Samuels 2313, Oct 1985 (NY).

NOTES: This fungus has been described in detail by Rogers (1981). Our material differs from Rogers' description primarily in having slightly shorter ascospores, (7.3-) 8.8-9.5(-10.3) X 5-6.5 μm vs (8-)9.5-11.7(-13) X (4-)5-6 (-7.3) μm . It is probable that the present material was somewhat immature.

Attempts to obtain cultures of our collection failed. Rogers (1982) has described cultural characteristics and the anamorph.

Hypoxyylon bovei Speg. var. microspora J. H. Miller, A monogr. of the world species of Hypoxyylon, p. 94. 1961.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah

Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 1951, 2010, Sep 1985 (NY,B0, JDR).

NOTES: Our material fits Miller's description (1961) of H. bovei var. microspora well. It was too depauperate to culture.

Hypoxylon crocopeplum Berk. & Curt., Grevillea 4: 49.

1875.

Figs. 37-39

Stromata much as described by Miller (1961). Asci longer than described by Miller, the spore-bearing parts 93-100 X 9-10 μm , with stipes 90-100 μm long, with apical rings bluing in Melzer's iodine reagent, rectangular, 2-3 μm high X 4.5-5 μm broad. Ascospores averaging somewhat larger than described by Miller, 13-17.5 X 6-8 μm , with conspicuous dehiscent perispore, with germ slit spore-length or somewhat less than spore-length.

Colonies on 2% potato dextrose agar with 5 g/l yeast extract at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, with mycelium felty, at first hyaline to white and slightly zonate, becoming fawn and ultimately charcoal-gray, paler toward center. Underlain with dark layer of hyphae and chlamydospores. Conidia produced over entire colony surface.

Chlamydospores thick-walled, indistinctly roughened, solitary or catenulate, globose to irregular, 13-25 X 5-10 μm . Conidiophores upright, indeterminate, irregularly to dichotomously branched, hyaline to pale orange, ultimately with conspicuous excrescences. Conidiogenous regions terminal or intercalary, cylindrical, the terminal regions 13-24 X 3-4 μm , bearing discoid conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, ellipsoid to obovoid, with flattened bases indicating former points of attachment to conidiogenous cell, (6-)8-11 X 4-5 μm . Anamorph Virgariella-like.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 2000, (cultured), Sep-Oct 1985 (NY,B0,JDR); same data, Samuels 2475 (NY,B0).

NOTES: The two collections of H. crocopeplum were very similar. Ascospores of no. 2000 were 13-15 X 6-7 μm , as

described by Miller (1961). Those of no. 2475 averaged slightly larger.

Hypoxylon hypomiltum Mont., Ann. Sci. Nat. Bot (Sér. 2)
13:356. 1840

Teleomorphic stromata as described by Miller, 1961.

Colonies on 2% potato dextrose agar with 5 g/l yeast extract at ca. 20 C under 12 hr fluorescent light not reaching periphery of 9 cm diam Petri plate in 4 wk, with mycelium velvety, at first hyaline, then white, becoming tan to gray-brown in center. Reverse reddish buff. No anamorphic structures observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 2004 (cultured), Sep 1985 (NY,BO,JDR); Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E; elev. 664 m, on wood, Samuels 2138, Oct 1985 (NY,BO,JDR).

NOTES: This ally of H. rubiginosum is widely distributed. It was not surprising to collect it in Sulawesi. See also notes on H. jecorinum herein.

Hypoxylon cf investiens (Schw.) Curt., Geol. and Nat.
Hist. Surv., North Carolina, part 3, p. 140. 1867.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Hog's Back Camp', 0°34'N, 123°51'E; elev. 492 m, on wood, Samuels 2476, Sep 1985 (NY,BO,JDR).

NOTES: This fungus looked much like H. investiens as described by Miller (1961), differing primarily in having smaller ascospores, 7-9.5 X 3-3.8 μm vs 8-11 X 3.5-5 μm . We were unable to culture this material.

Hypoxylon jecorinum Berk. & Rav., Grevillea 4: 50. 1875.
Fig. 36

Teleomorphic stromata as described by Miller (1961).

Colonies on 2% potato dextrose agar with 5 g/l yeast extract at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, floccose, hyaline, becoming white, ultimately dark brown and with agar stained deep

reddish brown. Conidiophores formed on aging colonies, usually obscured by overlying aerial mycelium.

Conidiophores upright, indeterminate, irregularly branched, at first smooth and hyaline, becoming roughened with reddish brown excrescences. Conidiogenous regions usually terminal, cylindrical, $13-22 \times (1.5-2(-2.5)) \mu\text{m}$, bearing apical clusters of conidia. Conidia produced holoblastically in apparent sympodial sequence. Conidia hyaline, smooth, ellipsoid to obovoid, with flattened bases indicating former points of attachment to conidiogenous cell, $(4-4.5-6 \times 2) \mu\text{m}$. Anamorph referable to Nodulisporium Preuss.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, $0^{\circ}34'N$, $123^{\circ}57'E$; elev. 211 m, on wood, Samuels 1934, Sep 1985 (NY,BO,JDR).

NOTES: Abe (1986) placed H. jecorinum into synonymy with H. hypomiltum. He cultured isolates from Japan; the cultural and anamorphic data seem identical with our data (above), but not with our data on what we have called H. hypomiltum elsewhere herein. We thus hesitate to accept Abe's concept of these species.

Hypoxylon maculosum J. D. Rogers, B. E. Callan & G. J. Samuels, sp. nov. Figs. 1,2,44,45,48

Stromata applanata vel aliquantum pulvinata, late effusa, ca. 1 mm crassa; extus atra cum albis maculis; intus atra; dura. Perithecia ca. 1 mm diametro. Ostiola inconspicua umbilicata. Asci saepe biseriate octospori, cylindrici, breviter stipitata, $160 \mu\text{m}$ longitudine tota $\times 10-14 \mu\text{m}$ crassi, partes sporiferae $130-135 \mu\text{m}$ longitudine, annulo apicali in liquore iodata Melzeri immerso cyanescente, urniformi, $7.2 \mu\text{m}$ alto $\times 4.4 \mu\text{m}$ crasso. Ascosporae brunneolae vel brunneae, unicellulares, ellipsoideo-inequilaterales vel aliquantum allantoidae, leves, $(17.5-20.5-24 \times (6-6.5-7.5(-10.3)) \mu\text{m}$, rima germinativa minus quam longitudine sporae. Status anamorphosis ignotus.

Stromata applanate to somewhat pulvinate, widespreading, ca. 1 mm thick, externally dull black mottled with white, internally black; hard. Perithecia ca. 1 mm diameter. Ostioles umbilicate, inconspicuous. Asci eight-spored, the spores often partially biseriate,

cylindrical, short-stipitate, 160 μm total length X 10-14 μm broad, the spore-bearing part 130-135 μm long, with the ascus apical ring bluing in Melzer's iodine reagent, urn-shaped, 7.2 μm high X 4.4 μm broad. Ascospores light brown to brown, one-celled, ellipsoid-inequilateral to somewhat allantoid, smooth, (17.5-)20.5-24 X (6-)6.5-7.5 (-10.3) μm , with germ slit less than full-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on *Livistonia*, Samuels 1991, Sep 1985 (HOLOTYPE, BO; ISOTYPE, NY, JDR).

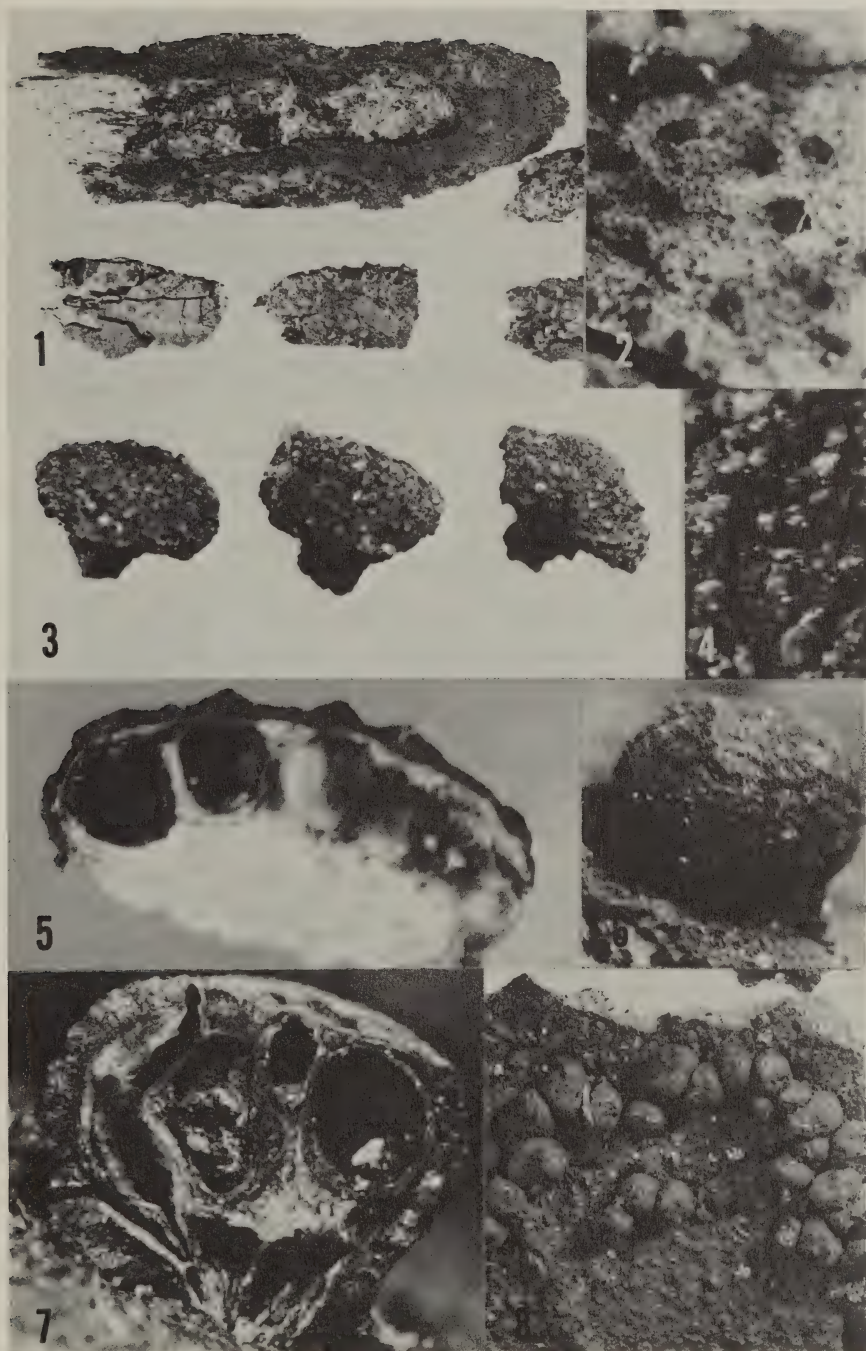
NOTES: Hypoxylon maculosum develops within bark in the manner of many representatives of Miller's section *Applanata* of Hypoxylon (1961). The well-developed urniform ascus apical ring and ascospore shape, however, are reminiscent of Miller's subsection *Primo-Cinerea* of section *Papillata* (1961). For the present, we are assigning H. maculosum to section *Applanata* primarily on the more or less applanate stroma and umbilicate ostioles. Anamorphic data would perhaps further elucidate the affinities of this species, but cultures were not obtained.

Hypoxylon nummularioides Rehm, *Ascomyc. Philippines* 4, Leaf 1. Philipp. Bot. 8, p. 2960. 1916.

Teleomorph as described by Miller (1961) except that asci are longer, the spore-bearing parts 160-200 X 11-16 μm with stipes 20-30 μm long, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 8 μm high X 5 μm broad. Ascospores average longer and narrower than described by Miller, 25-31 X 7-9 μm , with germ slit full-length, often with flaring noncellular (secondary) appendages.

Colonies on 2% potato dextrose agar with 5 g/l yeast extract at ca. 20 C under 12 hr fluorescent light covering

Figs. 1-8. 1,2. Hypoxylon maculosum. 1. Stromata, X 0.75. 2. Stromatal surface, X 16. 3-5. Kretzschmaria intracolorata. 3. Stromata, X 8. 4. Stromatal surface, X 24. 5. Stromatal section, X 36. 6-8. Penzigia sp. no. 2461. 6. Stroma, X 12. 7. Stromatal section, X 16. 8. Stromata, X 1.5.



9 cm diam Petri plate in 2 wk, white, velvety. Reverse white to pale buff. Anamorph not observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°34'N, 123°51'E; elev. 664 m, on vine, Samuels 2051, Oct 1985 (NY,BO,JDR).

NOTE: This fungus has been infrequently collected; few specimens are extant. Our collection was from a monocot, probably arecoid palm. Other reported collections are from bamboo.

Hypoxyton cf oodes Berk. & Broome, J. Linn. Soc. 14: 122. 1873.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°34'N, 123°51'E; elev. 664 m, on wood, Samuels 2145 (NY,BO,JDR); vic. 'Hog's Back Camp', 0°35'N, 123°51'E, elev. 492 m, on wood, Samuels 2181 Oct 1985 (NY,BO,JDR).

NOTES: These collections seem to represent H. oodes, differing primarily in the tan to brown stomatal coloration rather than the typical lilac coloration, as described by Miller (1961). The ascus tip rings are very thin and plate-like, those of 2181 bluing faintly in Melzer's iodine reagent and those of 2145 not bluing at all.

We were unable to obtain cultures from these collections.

Hypoxyton rubellum Penz. & Sacc. emend. J. D. Rogers, B. E. Callan & G. J. Samuels. Figs. 28-35

Stromata pulvinate, 1-3 mm X 1-3 mm X 0.5-1 mm thick, externally dull brown; sulfur yellow to orange immediately beneath surface and black beneath perithecia; soft.

Perithecia 0.2-0.3 mm diam, the contours usually evident on stromata. Ostioles umbilicate. Asci eight-spored, cylindrical, with short stipes, the spore-bearing part 125-160 X 8-9 μ m broad, with ascus apical ring bluing in Melzer's reagent, plate-like, 1.5 μ m high X 4.4 μ m broad. Ascospores brown to dark brown, unicellular, ellipsoid-inequilateral to somewhat rhomboid with more or less acute apices, ornamented with shallow pits in a somewhat reticulate manner, (14.7-)17.6-22(-23.5) X (6.5-)7-9(-10) μ m, with long straight germ slit whose margins protrude in the manner of clam shell sutures.

Colonies on 2% potato dextrose agar with 5 g/l yeast extract at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 1 wk, with mycelium woolly, gray to greenish gray. Reverse black. Conidia produced abundantly over entire plate.

Conidiophores upright, usually unbranched or asymmetrically branched, hyaline or subhyaline, smooth to warty, 30 μ m to at least 120 μ m total length X 2-3 μ m. Conidiogenous regions terminal or intercalary, the terminal ones in whorls or pseudowhorls with apices somewhat inflated and bearing inconspicuous conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, ellipsoid to obovoid to rectangular, with flattened bases indicating former points of attachment to conidiogenous cell, 5-7 X 2-2.5(-3) μ m.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°34'N, 123°51'E; on palm, Samuels 2120, Oct 1985 (NY,B0).

NOTES: Hypoxylon rubellum was described by Penzig and Saccardo (1904) on a collection from Java. Their description fits our material very well, except that ascospore ornamentation was not mentioned. We have examined type material [JAVA. Penzig, O. and P. A. Saccardo, no. 349, Tjibodas, on monocot stem (PAD)] and, although it is depauperate, were able to demonstrate pits on a few ascospores. Type material differs from ours in that the stromatal subsurface color is orange rather than bright yellow.

Miller (1961) did not see H. rubellum but guessed it to be H. rubrostromaticum. In fact, these are to be considered as separate taxa without obvious close relationship.

Hypoxylon rubigineo-areolatum Rehm, Ann. Mycol. 6: 345. 1908.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. Komangaan, limestone caves, 0°49'N, 124°12'E, elev. 400 m, Samuels 2357B, (NY,B0,JDR).

NOTES: Our material is typical of this species, which was well-described by Miller (1961). We did not obtain cultures.

Hypoxylon sp., a member of the rubiginosum complex.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Amadi Hot Springs, vic. Maleo bird nesting site, in old banana plantings, on wood, Samuels 2326, 22 Oct 1985 (NY,JDR).

NOTES: This fungus differs from typical H. rubiginosum, as described by Miller (1961), in having yellow granules just beneath the stromatal surface and in having minute sculpturing of the dehiscent ascospore perispore. It is probably unwise to make any formal taxonomic decision on this (and similar collections from elsewhere) until the brightly colored Hypoxylons have been studied and re-evaluated.

Hypoxylon rubiginosum Pers.: Fr. var. dieckmanni (Theiss.) J. H. Miller, A monogr. of the world species of Hypoxylon, p. 33. 1961.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 2036, Sep 1985 (NY,B0,JDR).

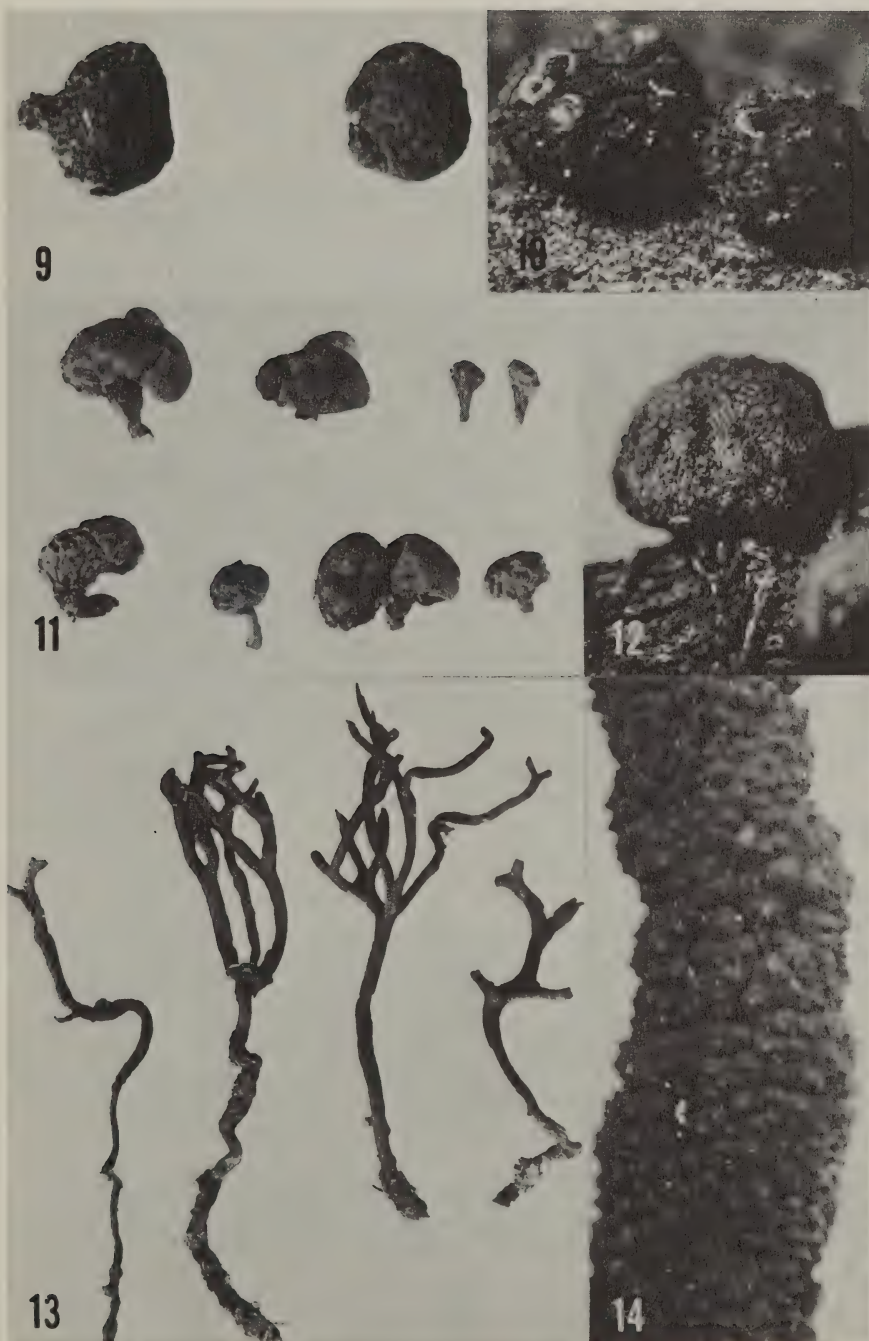
NOTES: This is a small-spored variant of H. rubiginosum which is widely distributed in the tropics. It has been well-described by Miller (1961). We did not culture this material.

Hypoxylon sclerophaeum Berk. & Curt., J. Acad. Nat. Sci. Philadelphia (ser. 2) 2: 285. 1853.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', 0°37'N, 123°51'E; elev. 1140 m, on log, Samuels 2095, 6,8 Oct 1985 (NY,B0,JDR).

NOTES: This is a widely distributed species, well-

Figs. 9-14. 9. Penzigia sp. no. 2418. Stromata, X 1.5. 10. Penzigia atosphaerica. Stromata, X 16. 11. Hypoxylon cadigensis. Stromata, X 2. 12. Penzigia sp. no. 2132. Stroma, X 5. 13,14. Xylaria angulosa. 13. Stromata, X 0.8. 14. Stromata surface, X 16.



described by Miller (1961). Our material seems typical. We did not attempt cultures owing to the poor condition of the material.

Hypoxylon sp.

Stroma fragmentary, probably pulvinate to hemispherical, at least 7 mm high, externally greyish yellow, internally blackish; hard. Perithecia 2-3 mm diam. Ostioles obscure, probably punctate. Asci not seen, but ascal fragments bore apical rings bluing in Melzer's iodine reagent, barrel-shaped, 16 μ m high X 11.8 μ m broad. Ascospores dark brown, unicellular, ellipsoid-inequilateral to oblong, smooth, 91-114 X 30-43 μ m, with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Ridgeway Camp', 0°29'N, 123°52'E; elev. 740 m, on log, Samuels 2293, 19 Oct 1985 (NY).

NOTES: This fungus has ascospores larger than those of any Hypoxylon known to us. It is very probably a new species, but our material is too scanty and fragmentary to be used as for describing a new taxon. Its relationships are with Hypoxylon nucigenum P. Henn., H. fragaria Ces. and some others. It is possible that this fungus has been described as a Penzigia, but we can find no record.

Hypoxylon sp.

Stromata pulvinate with steep margins, 2 mm high X 5 mm long and broad, externally dull black, internally blackish; very carbonaceous. Perithecia ca. 1 mm diameter. Ostioles papillate on discs 0.3 mm diameter, the discs often white. Asci eight-spored, cylindrical, long-stalked, 180-200 (or +) μ m total length X 8 μ m broad, spore-bearing parts 85 μ m, with apical ring bluing in Melzer's iodine reagent, 4.4 μ m high X 2.9 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 11-13.5 X 6-6.5 μ m, with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Muajat, Danau Alia, 0°45'N, 124°25'E, elev. 1400 m, on wood, Samuels 2404, 26 Oct 1985 (NY, BO, JDR).

NOTES: This fungus does not correspond well with any Hypoxylon known to us. It is close to H. michelianum Cēs. & DeNot., but has broader ascospores and longer ascus stalks than that species. Additional collections, however, might well show that it is merely a variant of H. michelianum.

Hypoxylon stygium (Lév.) Sacc., Sylloge Fung. 1, p. 379. 1882.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 1979, 2322 (NY,BO,JDR), Sep-Oct 1985 (NY,JDR); second collection on palm, Samuels 2039 (NY,BO); Dumoga-Bone National Park, voc. 'Hog's Back Camp', 0°35'N, 123°51'E, on wood, Samuels 2177, 30,31 Oct 1985 (NY,BO,JDR).

NOTES: Hypoxylon stygium is found in subtropical and tropical regions of the world. It has been well-described by Miller (1961). Our material was not cultured.

Hypoxylon uniapiculatum (Penz. & Sacc.) J. H. Miller, A monogr. of the world species of Hypoxylon, p. 111. 1961.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at the confluence of the Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E; elev. 211 m, on wood, Samuels 1970, Sep 1985 (NY,BO,JDR).

NOTES: Our collection fits Miller's description of H. uniapiculatum, except that the ascospores average smaller, i.e., 9.5-10.5 X 4.5-6 μ m vs 10-13.6 X 5-6.8 μ m (1961). Our material was in poor condition and was not cultured.

Hypoxylon uniapiculatum (Penz. & Sacc.) J. H. Miller var. macrosporum J. D. Rogers, Mycologia 67: 1061. 1975.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', 0°37'N, 123°51'E, elev. 211 m, on bark, Samuels 2099A, 3-5 Oct 1985 (NY,BO,JDR).

NOTES: This fungus is very much like type material of H. uniapiculatum var. macrosporum as described by Rogers

(1975), differing in its somewhat larger ascospores, i.e., $17.5\text{--}22 \times 8.8\text{--}11.8 \mu\text{m}$ vs. $(14\text{--})15\text{--}18\text{--}(20) \times (6\text{--})7\text{--}10\text{--}(11) \mu\text{m}$. We were unfortunately unable to obtain cultures from our material. Rogers (1975) described cultures bearing the anamorph initiated from type material.

A very similar fungus with much larger ascospores is H. philippinense (Ricker) J. H. Miller.

Kretzschmaria clavus (Fr.) Sacc., Sylloge Fung. 2,
addendum p. 29. 1883.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', $0^{\circ}37'N$, $123^{\circ}51'E$, elev. 1140 m, on wood, Samuels 2098A, 3-5 Oct 1985 (NY,BO,JDR); between 'Maddison's Camp' ($0^{\circ}36'N$, $123^{\circ}50'E$, elev. 980 m) and 'Camp 1440' ($0^{\circ}37'N$, $123^{\circ}51'E$, elev. 1140 m), on wood, Samuels 2174, 5 Oct 1985 (NY,BO,JDR).

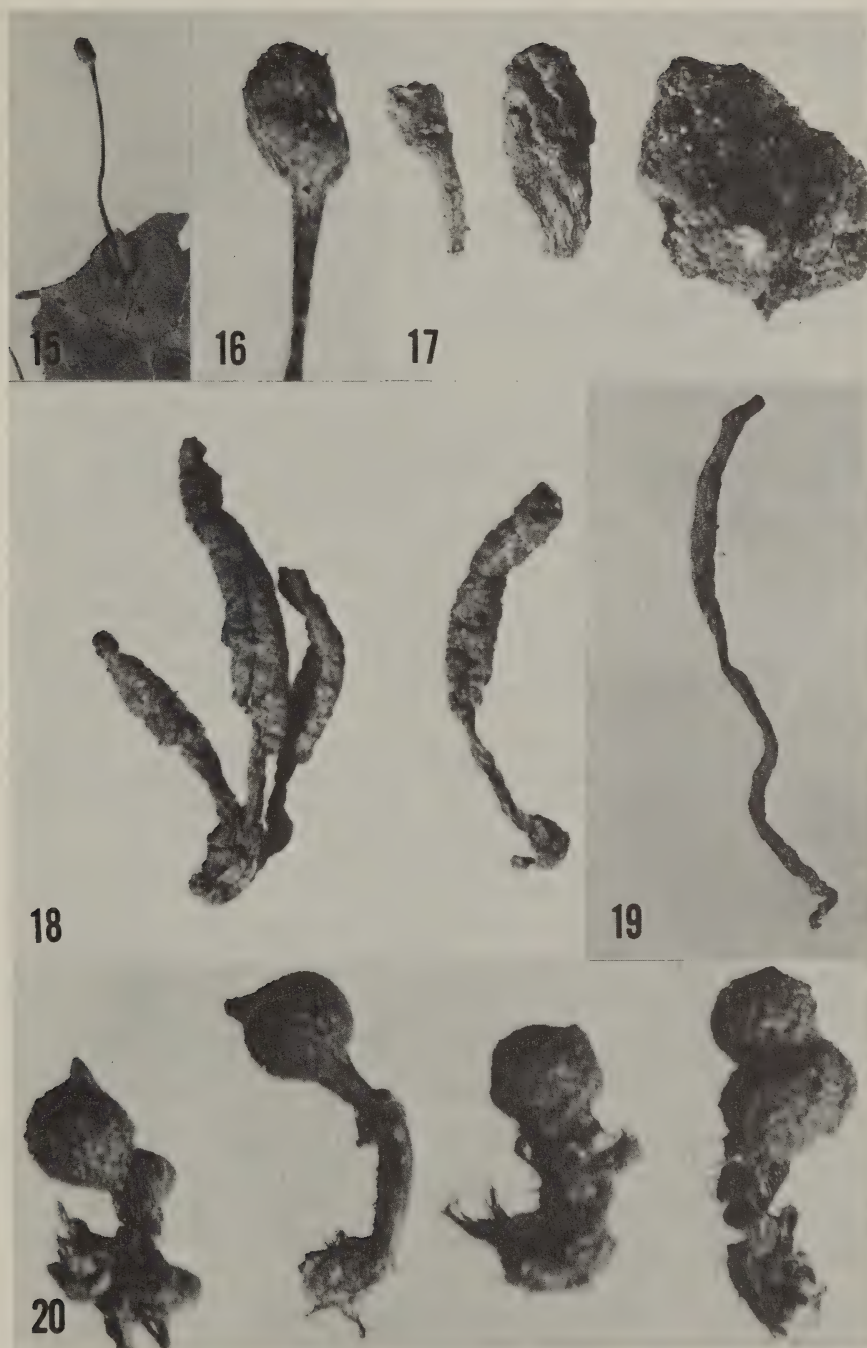
NOTES: Our material was in poor condition. It was much the same as described and illustrated by Dennis (1957). Cultures were not obtained from our material.

Kretzschmaria heliscus (Mont.) Masee, Kew Bull. 1898:
118. 1898.

Stromata convex on narrow stipes, 2-3 mm high $\times$ 2-3 mm broad, aggregated into crusts, externally black, internally white. Stromatal surface roughened with warts and corky-cracking. Perithecia 0.5-0.7 mm diam. Ostioles papillate, often discoid. Asci eight-spored, the spores often partially biserial in arrangement, cylindric-clavate, long-stipitate, $135\text{--}140 \mu\text{m}$ total length $\times$ $10 \mu\text{m}$ broad, the spore-bearing part $49\text{--}56 \mu\text{m}$, with the apical ring bluing in Melzer's iodine reagent, rectangular, $2.2 \mu\text{m}$ high $\times$ $1.5 \mu\text{m}$ broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, $9\text{--}10 \times 5\text{--}6 \mu\text{m}$, with inconspicuous straight germ slit spore-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-

Figs. 15-20. 15,16. Xylaria hypsipoda var. microspora. 15. Stroma, $\times 2.8$. 16. Detail of stromatal head, $\times 18$. 17. Xylaria clavus. Stromata, $\times 9$. 18. Xylaria fissilis. Stromata, $\times 3$. 19. Xylaria nigripes. Stroma, $\times 0.6$. 20. Xylaria copelandii. Stromata, $\times 24$.



Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 2033, Sep 1985 (NY,BO,JDR).

NOTES: This fungus is much as illustrated by Dennis (1957). He speculated that it is a state Xylaria feejeensis (Berk.) Fr. Unfortunately, we did not obtain cultures from our material.

Kretzschmaria intracolorata J. D. Rogers, B. E. Callan & G. J. Samuels, sp. nov. Figs. 3-5,46,47,49

Stromata complanata vel convexa, stipitibus brevibus, 2-4 mm alta X 2-4 mm crassa, extus nigra; proxime sub superficie flava vel aurantiaca, proxime sub peritheciis alba; dura et fragilia. Perithecia 0.3-0.4 mm diametro. Ostiola papillata, in disco minus quam 0.1 mm diametro. Asci saepe biseriate octospori, cylindrici, longe stipitati, 105-125 μ m longitudine tota X 6-10 μ m crassi, partibus sporiferis 53-65 μ m longitudine, annulo apicali in liquore iodata Melzeri immerso cyanescente, oblongo, 2.2 μ m alto X 1.5-2.2 μ m crasso. Ascosporae brunneae, unicellulares, ellipsoideo-inaequilaterales, leves, (8.8-) 10-12 X 4.5-5 μ m, rima germinativa longa praedita. Status anamorphosis ignotus.

Stromata flat-topped to convex on short stipes, 2-4 mm high X 2-4 mm broad, externally black; yellow to orange immediately beneath surface and white beneath perithecia; brittle and fragile. Perithecia 0.3-0.4 mm diameter. Ostioles papillate in a minute disc less than 0.1 mm diameter. Asci eight-spored, the spores often partially biseriate, cylindrical, long-stipitate, 105-125 μ m total length X 6-10 μ m broad, the spore-bearing parts 53-65 μ m long, with the apical ring bluing in Melzer's iodine reagent, rectangular, 2.2 μ m high X 1.5-2.2 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, (8.8-)10-12 X 4.5-5 μ m, with straight germ slit full-length. Anamorph unknown.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on recently fallen tree, Samuels 2079, 6,8 Oct 1985 (HOLOTYPE, BO; ISOTYPE, NY); data as holotype, Samuels 2131 (NY,BO).

NOTES: This is the only Kretzschmaria known to us with colored granules beneath the black stromatal surface. The

flattened ostiolar discs are noteworthy. We were unable to obtain cultures from our material.

Kretzschmaria cf mauritanica Pat., Bull. Soc. Mycol.
France 20: 120. 1905.

Stromata nail-shaped, up to 2 mm high X 4 mm broad, externally black with patches of white bloom, internally white; texture woody. Stromatal surface deeply cracked with tomentum in cracks. Perithecia 0.3-0.5 mm diam. Ostioles obscure. Asci eight-spored, the spores sometimes partially biseriate in arrangement, cylindric-clavate, long-stipitate, 260-280 μ m total length X 10-15 μ m broad, the spore-bearing part 130-137 μ m, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 7.3 μ m high X 4.4 μ m broad. Ascospores dark brown, unicellular, ellipsoid-inequilateral to crescentic, with rounded or abrupt ends, smooth, (19-)20.6-25 X 6.6-8 μ m, with germ slit spiralling, much shorter than spore-length.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, on fallen tree, Samuels 1947, Sep 1985 (NY,BO,JDR).

NOTES: We have not seen type material of this species. It resembles a collection at K from Congo (Fassi, A. 897). The surface of our material resembles a deeply cracked chocolate cookie that has been dusted with sugar. We were unfortunately unable to culture this fungus.

Kretzschmaria cf microspora P. Henn., Hedwigia 43: 261.
1904.

Stromata more or less nail-shaped on short stipes, 1-2 mm high X 2-3 mm broad, aggregated into crusts, externally black, internally white. Brittle and fragile, the interior flesh deteriorating by maturity. Perithecia 0.5-1 mm diam. Ostioles papillate in minute disc. Asci with 8 or fewer ascospores, cylindrical, long-stipitate, 200-220 μ m total length X 5 μ m broad, the spore-bearing part 70-90 μ m long, with the apical ring bluing in Melzer's iodine reagent, rectangular, 1.5 X 1.5 μ m. Ascospores brown, unicellular, ellipsoid-inequilateral to somewhat crescentic, smooth, 9-11 X 3.7-4.4 μ m, with straight germ slit less than spore-length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, at first velvety, white and slightly zonate, becoming overlain with greyish black mycelium and developing fine radiating furrows. Reverse pale rose. Stromata 1 mm high X 1 mm diam formed over colony surface. No anamorphic structures observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on Livistonia, Samuels 1964, Sep 1985 (NY,BO,JDR).

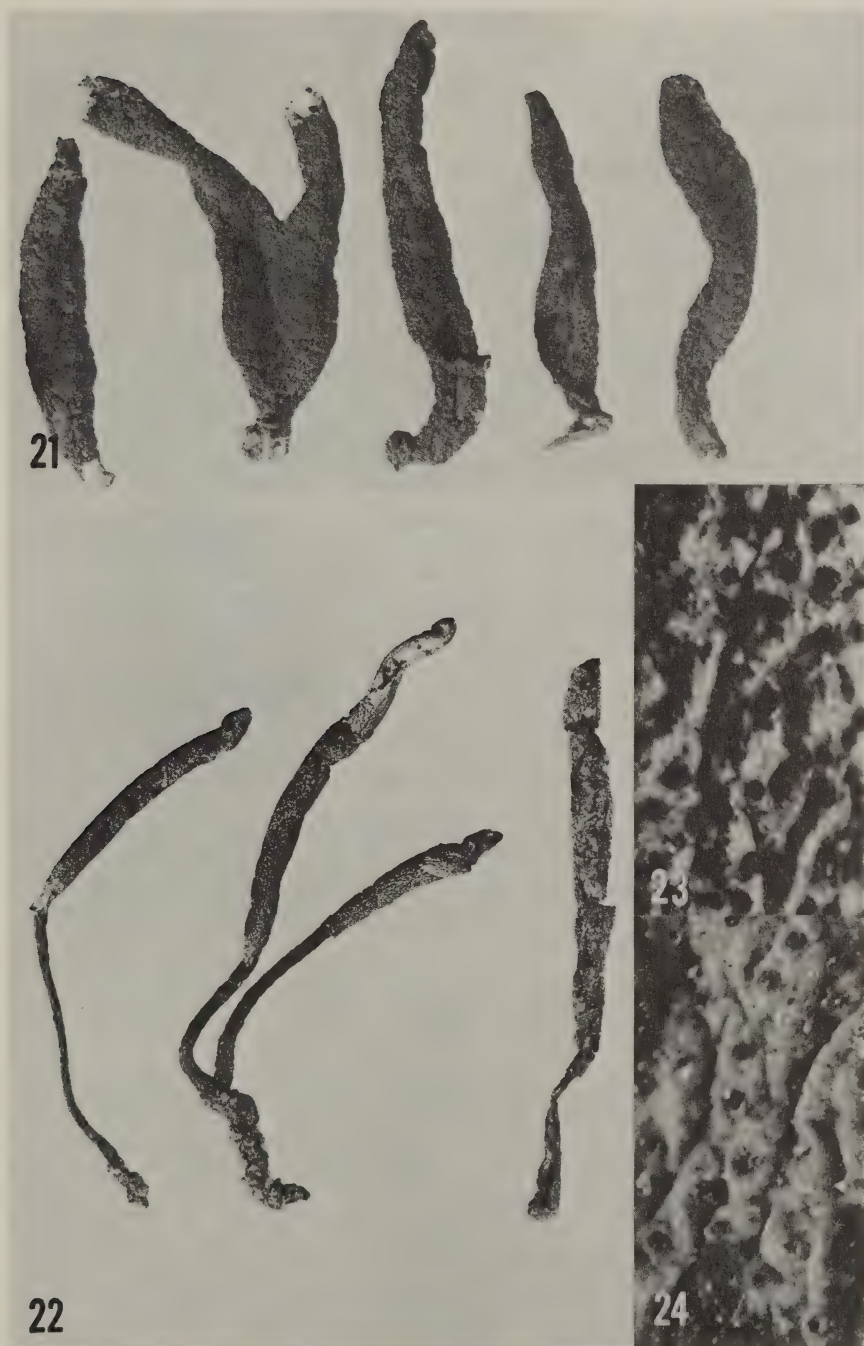
NOTES: Our material is much as described and illustrated by Dennis (1957) except that our material is stipitate. Henning (1904) described it as "... subovoideis haud stipitatis ..." On the other hand, Henning (1904) described the ostioles as "... papillatis, disco subannulato circumdantibus ...," fitting our material exactly.

Penzigia cf atosphaerica (Cooke & Massee) J. H. Miller, Mycol. Explor. Venezuela, Monogr. Univ. Puerto Rico, ser. B, 2, p. 212. 1934. Figs. 10,53-55

Stromata pulvinate to hemispherical, ca. 2 mm diam, externally grayish black, internally white. Surface smooth except for minute cracks and ostioles. Texture soft. Perithecia 0.4-0.5 mm diam. Ostioles papillate. Asci eight-spored, cylindrical, long-stipitate, 160-190 μ m total length X 9-10 μ m broad, the spore-bearing part 95-100 μ m, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 5 μ m high X 3.7 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 17.6-22 X 7.3-9 μ m, with germ slit short to sigmoid, much less than spore-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on twigs, Samuels 2100, 6,8 Oct 1985 (NY,BO).

Figs. 21-24. 21. Xylaria luteostromata. Stromata, X 2. 22,23. Xylaria melanaxis. 22. Stromata, X 0.85. 23. Stromatal surface, X 24. 24. Xylaria nigripes. Stromatal surface, X 16.



NOTES: Our specimen resembles type material [Brisbane (K)(as Hypoxylon atosphaericum Cooke & Masee)]. Type material is so depauperate that we did not seek ascospores. We were unable to culture our material.

Hypoxylon cf. cadigensis Yates, Philipp. J. Sci. 12: 378. 1917. Figs. 11,60,62,63

[Widely called Penzigia cadigensis (Yates) J. H. Miller, a herbarium name. See "A monogr. of the world species of Hypoxylon, p. 134. 1961.]

Stromata hemispherical to irregular, on abrupt narrow stipe, 2-3 mm high X 7 mm diam, externally black, internally white. Texture very hard. Surface smooth except for few wrinkles and ostioles. Perithecia 0.5-0.7 mm diam. Ostioles finely papillate. Asci not observed intact. Ascus apical ring bluing in Melzer's iodine reagent, urn-shaped, 5.9 μ m high X 2.9 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, with rounded or abrupt apices, smooth, 20.6-23.5 X 6.6-7.3 μ m, with germ slit straight, oblique, much less than spore-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 2024, Sep 1985 (NY,BO,JDR).

NOTE: This fungus is much like type material (Yates, H. S., XII.1916, Luzon, Philippines (K)]. Type material lacks asci. Ascospores are strongly inequilateral with acute apices; no germ slits were seen. We were unable to culture our collection.

Penzigia cranioides Sacc. & Paol., Atti R. Ist. Venet. Sci. (ser. 6) 6: 406. 1888.

Stromata globoid on narrowed base, 2.5 cm diam, externally yellowish white, blackened at base, hollow, the internal flesh apparently at first white; surface smooth, very hard. Perithecia 1 mm diam. Ostioles umbilicate, inconspicuous. Intact asci not seen. Ascus apical ring bluing in Melzer's iodine reagent, urn-shaped, 7.3 μ m high X 3.6 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 24-30 X 8-9.5(-10.3) μ m, with slit slightly or greatly less than spore-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Poniki, between 'Wien Camp' (0°28'N, 123°51'E, elev. 810 m) and 'Ice Station Zebra Camp' (0°26'N, 123°49'E, elev. 1520 m), Samuels 2289, 19 Oct 1985 (NY,BO,JDR).

NOTES: Dennis (1961) considered P. cranioides, the type species of Penzigia, to be a hemispherical form of Xylaria fockei (Miq.) Cooke (= X. dealbata Berk. & Curt.). Type material of X. fockei [Focke 1267, Surinam (K)] has ascospores with very acute apices. We have not examined type material of P. cranioides, but have examined collections from various parts of the world that have ascospores much as described herein. For the present, we consider P. cranioides and X. fockei to be distinct taxa.

We were unable to culture our material.

Penzigia macrospora Penz. & Sacc., Icones Fung. Javanicorum, p. 27. 1904.

Stromata convex on attenuated stipe, 2-3 mm high X 3 mm diam, externally white with bright rust orange blotches covering a black layer, internally white; texture rather soft. Perithecia 1 mm or more diam. Ostioles raised, more or less punctate. Asci eight-spored, the spores arranged in uniseriate or biseriate manner, cylindrical-clavate, sessile or very short stipitate, 155-205 µm total length X 30-35 µm broad, without discernible apical ring, not bluing in Melzer's iodine reagent. Ascospores nearly black, unicellular, broad ellipsoid-inequilateral to football-shaped, smooth, sometimes with noncellular (secondary) appendages, 29.4-35.3 X (11.8-)17.6-20.6 µm, with straight germ slit spore-length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light not covering 9 cm diam Petri plate in 4 wk, at first appressed, white and zonate, becoming wrinkled and rugose, dark reddish brown. Reverse reddish brown. No anamorphic structures observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', 0°37'N, 123°51'E, elev. 1140 m, on wood, Samuels 2093, 3-5 Oct 1985 (NY,JDR).

NOTES: This fungus is much like holotype material of P. macrospora from Java [Tjibodas, 3/2/1897 (PAD)]. Penzigia indica Rawla & Narula is a similar fungus with a large apical ring which reddens somewhat in iodine and sometimes

blues at the base (Rawla & Narula, 1984). The fungus that they earlier described as *P. macrospora* is not that species (Rawla & Narula, 1983). *Penzigia cretacea* (Berk. & Broome) Sacc. & Paol. is a similar fungus and might be conspecific. We have not seen material of this fungus which was originally described from Australia.

Penzigia sp.

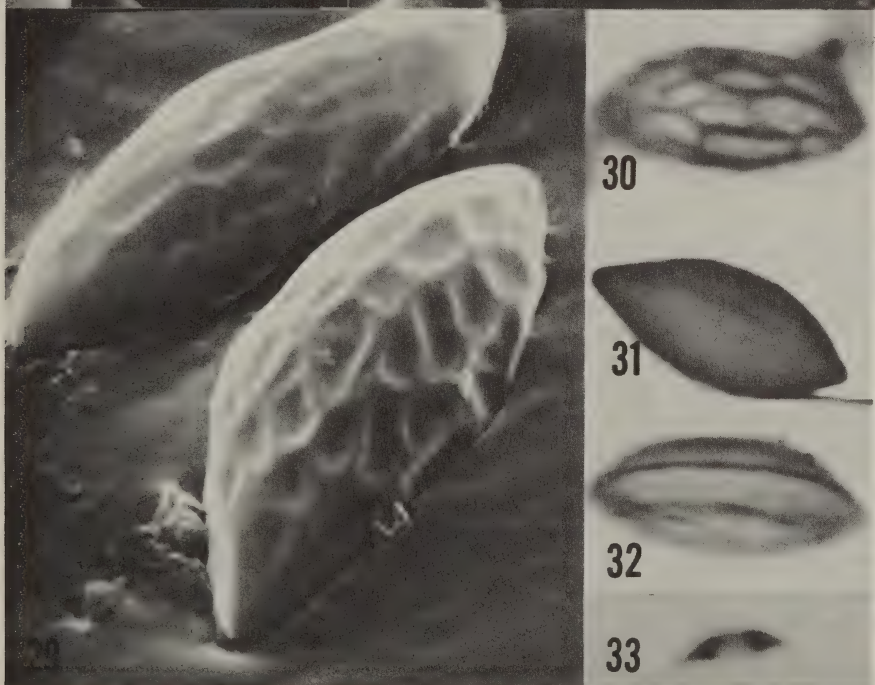
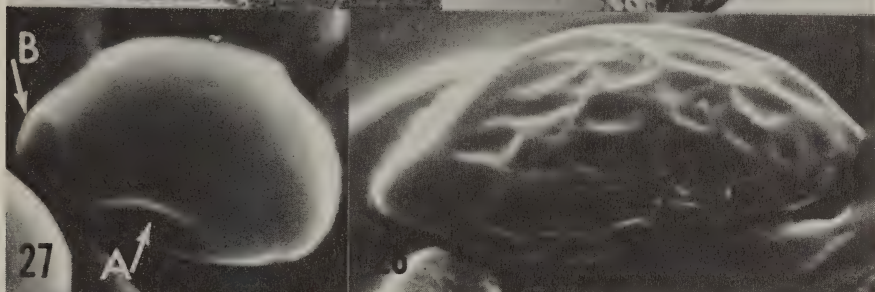
Figs. 6-8

Stromata globoid to irregular on a narrow connective, solitary to crowded, 5-10 mm diam, externally black, internally white, fibrous, becoming hollow as flesh disintegrates; outer part very hard. Surface minutely and regularly warty. Perithecia 0.7-1 mm diam. Ostioles barely raised, essentially umbilicate. Asci eight-spored, cylindrical, long-stipitate, 240 μ m total length X 10 μ m broad, spore-bearing part 175 μ m, with apical ring bluing in Melzer's iodine reagent, urn-shaped, 7.3 μ m high X 4.4 μ m broad. Ascospores nearly black, unicellular, long fusoid to crescentic, smooth, 31-37 X 6-7.3 μ m, with straight or oblique germ slit much less than spore-length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light never reaching periphery of 9 cm diam Petri plate, appressed, at first white, then overlain with dark gray hyphae which bears a surface layer of tightly coiled hyaline hyphae. Colonies eventually developing radial furrows which split, the mycelium detaching from the agar and curling. Anamorphic structures not observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone Natinal Park, Gn. Muajat, Danau Alia, 0°45'N, 124°25'E, elev. 1400 m, on wood, Samuels 2378 (cultured), 26 Oct 1985 (NY,BO,JDR); Dumoga-Bone National Park, vic.

Figs. 25-33. 25,26. *Xylaria* sp. no. 2454. 25. Stromata, X 3. 26. Detail of stromatal head, X 16. 27. *Xylaria melanaxis*. Scanning electron micrograph of ascospore. Sunken germ pore (A) and cellular appendage (B), X 10000. 28-33. *Hypoxyton rubellum*. 28,29. Shallowly pitted surface of ascospores by scanning electron microscopy, X 4000. 30. Pitted surface of ascospores by brightfield light microscopy, X 2400. 31. Fully colored ascospore depicting shape, X 2400. 32. Protruding ascospore germ slit, X 2400. 33. Ascus apical ring stained in Melzer's reagent, X 3100.



'Hog's Back Camp', 0°35'N, 123°51'E, elev. 492 m, on wood, Samuels 2461, Nov 1985 (NY,BO).

NOTES: This fungus seems allied to Penzigia cantareirensis (P. Henn.) J. H. Miller ($\equiv$ Hypoxyylon cantareirensis P. Henn.). The ascospores of our fungus average longer and more narrow than those of that fungus.

Penzigia sp.

Fig. 9

Stromata pulvinate to hemispherical on a narrow connective, up to 13 mm diam, externally black, internally white, becoming hollow, brittle and fragile. Perithecia ca. 0.7 mm diam. Ostioles more or less punctate, obscure. Asci in poor condition, indescrivable, the apical portion not bluing in Melzer's iodine reagent. Ascospores dark brown, unicellular, more or less rectangular to irregular, smooth, 37-44 X 16-19 μ m, with long undulating to spiraling germ slit.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Muajat, Danau Alia, 0°45'N, 124°25'E, elev. 1400 m, on wood, Samuels 2418, 26 Oct 1985 (NY,BO).

NOTES: This fungus possibly represents an undescribed taxon. We are not describing it here owing to the poor condition of specimens and failure to obtain cultures.

Penzigia sp.

Figs. 12,50-52

Stromata hemispherical to subglobose on very short narrowed stipe or connective, up to 4 mm high X 6 mm broad, externally at first gray, becoming orange brown with dark lines or furrows, internally white; hard. Perithecia ca. 1 mm diam. Ostioles papillate. Asci in poor condition and not describable, the apical ring bluing in Melzer's iodine reagent, urn-shaped, 5.9 μ m high X 3.7 μ m broad. Ascospores nearly black, unicellular, ellipsoid-inequilateral with abrupt narrow to acute ends, smooth, 23-26.5 X 7.3-8 μ m, with germ slit 1/2 - 2/3 spore-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on recently fallen tree, Samuels 2132, 6,8 Oct 1985 (NY,BO).

NOTES: Mature specimens of this fungus resemble members

of subsection Papillata, section Papillata of Hypoxylon (Miller, 1961) in the external color and papillate ostioles. The whitish fibrous interior is reminiscent of subsection Primo-cinerea, section Papillata of Hypoxylon or of Xylaria. Unfortunately, only fragments of the anamorph were seen on immature stromata and attempts to initiate cultures failed. Moreover, our collection is scanty and depauperate. We are thus unable to deal with it in a taxonomically satisfactory way.

Rosellinia necatrix Prillieux, Bull. Soc. Mycol. France
20:34. 1904.

Stromata perithecioid, spherical, 1-1.2 mm diam, cespitose, externally reddish brown, internally brown with sulfur yellow zone next to perithecial wall. Ostioles papillate. Embedded in coarse blackish subiculum. Asci eight-spored, the spores arranged in a partially biseriata manner, cylindrical, long-stipitate, 290 μ m total length X 12 μ m broad, spore-bearing part 170-210 μ m, with apical ring bluing in Melzer's iodine reagent, more or less urn-shaped, 10.5 μ m high X 6 μ m broad. Ascospores brown, unicellular, long fusoid-inequilateral, smooth, 34-44 X 5.9-6.6 μ m, with short, straight to oblique germ slit.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on recently fallen tree, Samuels 2053, 6,8 Oct 1985 (NY,BO).

NOTES: It is surprising that the large and cosmopolitan genus Rosellinia was represented only by this single collection of R. necatrix. This fungus has been reported from various temperate and tropical regions of the world. We were unable to obtain cultures from our material.

Xylaria angulosa J. D. Rogers, B. E. Callan & G. J.
Samuels, sp. nov. Figs. 13,14,56,61

Stromata erecta sine ramis vel multiramosa, ramis ad angulum 90° patentibus, arbuscularia, similia eis Thamnomycetum, radicibus longis, in totis ad 12 cm alta X 2-3 mm crassa; partibus fertilibus peritheciis aggregatis instructis; extus nigra, intus brunneola; dura et fragilia. Perithecia 0.2-0.3 mm diametro. Ostiola fortiter papillata, partibus fertilibus ad tactum scabrosis. Asci octospori, cylindrici, stipitati, 55 μ m longitudine tota X 4

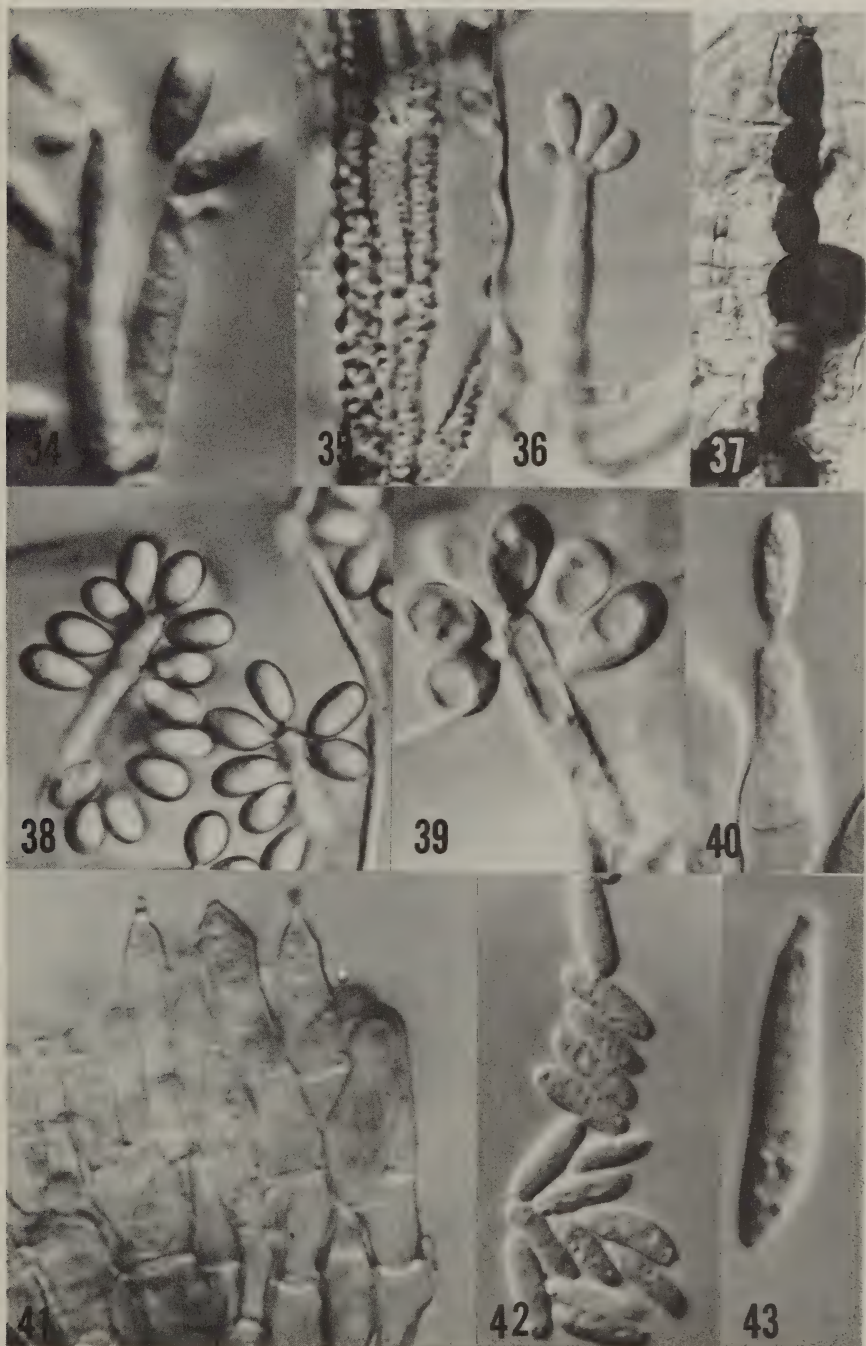
μm crassi, partibus sporiferis 32-38 μm longitudine, annulo apicali in liquore iodata Melzeri immerso cyanescente, minuto. Ascosporae brunneae, unicellulares, ellipsoideo-inaequilaterales, leves, 4.4-5 X 2.2-3 μm , rima germinativa longa praeditae. Status anamorphosis ignotus.

Stromata upright, unbranched or highly branched, the branches often arising from broad angles approaching 90 degrees, appearing arbusculate and reminiscent of Thamnomycetes, with long rooting stipes, the whole up to 12 cm high X 2-3 mm thick; fertile parts bearing crowded perithecia; exterior black, interior brownish. Texture hard and brittle. Perithecia 0.2-0.3 mm diameter. Ostioles strongly papillate, collectively giving the fertile parts of stromata the feel of sandpaper. Asci 8-spored, cylindrical, stipitate, 55 μm total length X 4 μm , the spore-bearing parts 32-38 μm , with apical ring bluing in Melzer's iodine reagent, minute. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 4.4-5 X 2.2-3 μm , with straight slit full-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Hog's Back Camp', 0°35'N, 123°51'E, elev. 492 m, on ground, Samuels 2465, 30,31 Oct 1985 (HOLOTYPE, BO; ISOTYPE, NY,JDR).

NOTES: Xylaria angulosa is distinguished by its branching pattern. According to field notes some stromata were olivaceous brown when fresh. The brittle stromata with dark flesh, the small asci and ascospores, and the long rooting bases clearly indicate a relationship with certain Xylaria species associated with insect nests, i.e., X nigripes, X. melanaxis. These fungi are poorly understood and in great need of taxonomic attention. Boedijn (1959)

Figs 34-43. 34,35. Hypoxylon rubellum anamorph. 34. Conidiogenous region and conidia, X 2600. 35. Warty conidiophores, X 900. 36. Hypoxylon jecorinum anamorph. Conidiogenous region bearing conidia, X 2000. 37-39. Hypoxylon crocopeplum anamorph. 37. Chain of chlamydospores, X 640. 38. Conidiogenous region with conidia, X 1200. 39. Conidiogenous region bearing conidia, X 1800. 40. Xylaria dealbata anamorph. Conidiogenous cell bearing conidium, X 1800. 41-43. Xylaria grammica anamorph. 41. Palisade of conidiogenous cells, X 1600. 42. Conidia, X 1000. 43. Conidium, X 2250.



put such fungi into Pseudoxylaria Boedijn on the basis of their habitats and the small ascospores apparently devoid of germ slits. Dennis (1961) accepted Pseudoxylaria as a subgenus. We do not accept Pseudoxylaria as a genus because all potential member species known to us have ascospores with germ slits and iodine-positive apical ascus rings. One species -- X. furcata Fr. -- has an unusual conidial state referable to Padixonia Subramanian. It is possible that related species have unusual anamorphs and, if so, would cause us to re-evaluate the usefulness of Pseudoxylaria. Unfortunately, we were unable to culture X. angulosa or any other related fungi discussed herein.

Xylaria anisopleura (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851.

Stromata as described by Dennis (1956, 1961). Asci in poor condition and not measured, apical ring bluing in Melzer's iodine reagent, urn-shaped, 5.9 μm high X 4.4 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral to crescentic, smooth, 23-30 X (6.6-)7.3-9 μm , with germ slit oriented oblique to long axis of spore, straight to curving, much shorter than spore-length.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Muajat, Danau Alia, 0°45'N, 124°25'E, elev. 1400 m, on arecoid palm, Samuels 2403, 2408, 26 Oct 1985 (NY,BO,JDR); third collection, same locality, on wood, Samuels 2419 (NY,BO,JDR).

NOTES: Xylaria anisopleura has been reported from various parts of the world. It is undoubtedly allied to X. polymorpha (Pers.: Fr.) Grev., X. schweinitzii Berk. & Curt., and X. scruposa (Fr.) Fr. We were unfortunately unable to obtain cultures from our material. BEC (unpublished) has shown that cultures from South American material are distinctive, reinforcing our concept of X. anisopleura as a taxon distinct from the aforementioned species.

Xylaria apiculata Cooke, Grevillea 8: 66. 1879.

Stromata conical to long cylindric-conic, 1.5-2 cm high X 2-3 mm broad, on long narrow stipes, up to 7 cm total length, externally with a gray peeling layer exposing underlying black surface, internally white. Texture fairly hard. Surface undulate to mostly smooth;

stipes hirsute. Perithecia 0.5-0.7 mm diam. Ostioles obscure. Asci eight-spored, cylindrical, either too immature or overmature to measure, with apical ring bluing in Melzer's iodine reagent, more or less rectangular, 4.4 μm high X 2.9 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 14.7-18.4 X (4.4-)6-6.6 μm , with germ slit straight to undulate, slightly less than spore-length. Anamorph not observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 1985, Sep 1985 (NY,JDR); second collection, same locality, on small sticks and petioles, Samuels 2038, Sep 1985 (NY,BO,JDR).

NOTES: The fungus described here fits our concept of X. apiculata, except that the ascospores average smaller than from New Zealand, the type location, i.e., (16-)20-24.5 (-30) X (5-)6.7-8(-9) μm (Rogers and Samuels, in press). We were unable to culture our material.

Xylaria arbuscula Sacc., *Michelia* 1: 249. 1878.

Stromata cylindrical to cylindric-conic, 5-15 mm high X 1-2 mm broad, on long thin stipe up to 4 cm long, solitary or branched, externally with a gray peeling layer exposing underlying black surface, internally white. Texture soft. Surface more or less smooth; stipe hirsute. Perithecia 0.3-0.4 mm diam. Asci eight-spored, spores sometimes arranged in partially biserial manner, cylindrical to cylindric-clavate, 160-175 μm total length X 6-10 μm broad, the spore-bearing part 90-96 μm , with apical ring bluing in Melzer's iodine reagent, more or less rectangular, 2.9-4.4 μm high X 1.5-2.2 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 11.7-14.7 X 4.4-5 μm , with germ slit straight, slightly less or much less than spore-length. Anamorph not observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 1944, Sep 1985 (NY,BO,JDR); same data, 1961 (NY,BO).

NOTES: The present collections fit our concept of X. arbuscula well. Ascospores of collections from New Zealand and elsewhere sometimes bear a tiny cellular (primary) appendage on one end (Rogers & Samuels, IN PRESS).

Appendages were not noted on ascospores of our material.

We were unable to obtain cultures from our material.

Xylaria beccari Lloyd, Mycol. Notes 71, Mycol. Writings 7: 1247. 1924.

Stromata cylindrical to clavate from short concolorous stipe, up to 5 mm total height X 1.5-3 mm broad, externally brownish black, internally white. Texture fairly soft. Surface highly roughened by rugosity and small excrescences. Perithecia 0.2-0.3 mm diam. Ostioles slightly papillate, inconspicuous. Asci eight-spored, cylindrical, long-stipitate, 100-140 μ m total length X 4-5 μ m broad, the spore-bearing parts 50-58 μ m, with apical ring bluing in Melzer's iodine reagent, rectangular, minute. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 6-7.3 X 3-3.7(-4.4) μ m, with straight germ slit spore-length. Anamorph not observed.

Figs 44-63. 44,45. Hypoxylon maculosum. 44. Ascospores, X 1470. 45. Ascospores showing germ slits, X 1470. 46,47. Kretzschmaria intracolorata. 46. Ascospores, one showing germ slit, X 1470. 47. Ascospores, X 1470. 48. Hypoxylon maculosum. Ascus apical ring stained in Melzer's reagent, X 1470. 49. Kretzschmaria intracolorata. Ascus apical ring stained in Melzer's reagent, X 1470. 50-52. Penzigia sp. no. 2132. 50. Ascospore showing germ slit, X 1470. 51. Ascospore, X 1470. 52. Ascus apical ring stained in Melzer's reagent, X 1470. 53-55. Penzigia atrosphaerica. 53. Ascus apical ring stained in Melzer's reagent, X 1470. 54. Ascospore showing germ slit, X 1470. 55. Ascospore, X 1470. 56. Xylaria angulosa. Ascospores, one of which shows germ slit, X 2700. 57. Xylaria nigripes. Ascospores, two of which show germ slits, X 2700. 58,59. Xylaria melanaxis. Ascospores showing germ pores (arrows), X 3100. 60. Hypoxylon cadigensis. Ascus apical ring stained in Melzer's reagent, X 1470. 61. Xylaria angulosa. Ascus apical ring stained in Melzer's iodine reagent, X 3100. 62,63. Hypoxylon cadigensis. 62. Ascospore, X 1470. 63. Ascospore showing germ slit, X 1470.



SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on log, Samuels 2117, 6,8 Oct 1985 (NY,BO, JDR); Samuels 2215.

NOTES: Our fungus fits Lloyd's description very well. We have seen what appears to be type material from Borneo in BPI. It is depauperate.

We were unable to initiate cultures from our material.

Xylaria cf berkeleyi Mont. apud Cooke, Grevillea 11: 85. 1883.

Stromata cylindric-clavate on abrupt short or long stipes, up to 3 cm high X 3 mm broad, cespitose with many stromata arising from a common base, externally black, internally white with a blackish central core. Texture hard. Surface rugose with remnants of peeling outer layer. Perithecia 0.5 mm diam. Asci eight-spored, cylindrical, stipitate, 120-135 μ m total length X 7 μ m broad, the spore-bearing part ca. 85 μ m, with apical ring bluing in Melzer's iodine reagent, rectangular to somewhat funnel-shaped, 2.2 μ m high X 1.5 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral to crescentic, smooth, (13-)14-16 X 4.4-6 μ m, with germ slit slightly less than full length. Anamorph not observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on wood, Samuels 2412, 6,8 Oct 1985 (NY,BO,JDR).

NOTES: Although this fungus is much like X. berkeleyi, the cespitose habit and the black central zone of the stromata are features that we have not previously encountered. We were unable to obtain cultures from our material.

Xylaria clavus Lloyd, Mycol. Writings 5: 688. 1917.

Fig. 17

Stromata clavate on short, ill-defined concolorous stipes, 2-10 mm total height X 1-3 mm broad, externally black with traces of white, internally white. Texture woody. Surface cracked and roughened. Perithecia 0.4-0.5 mm diam. Ostioles discoid, inconspicuous. Asci eight-spored, cylindrical, long-stipitate, 260-300 μ m total length X 8-13 μ m wide, spore-bearing part 130-140 μ m, with apical ring bluing in Melzer's iodine reagent, urn-shaped,

7.3-8.8 μm high X 3.7-5.9 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral to crescentic, smooth, 20.6-25(-25.7) X 6-8.8 μm , with germ slit straight to sigmoid oriented oblique to long axis of spore, much less than spore-length. Anamorph not observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, between 'Maddison's Camp' (0°36'N, 123°50'E, elev. 980 m) and 'Camp 1440' (0°37'N, 123°51'E, elev. 1140 m), on live vine, Samuels 2162, 5 Oct 1985 (NY,BO,JDR); same locality and date, on wood, Samuels 2163 (NY,BO,JDR).

NOTES: Our material is very much like type material [JAVA: Mousset, J., X.1911, Lawang, Lloyd 10011 (BPI)]. This species seems closely allied to X. anisopleura. Unfortunately, we were unable to obtain cultures from our material.

Xylaria cf copelandii P. Henn., Hedwigia 47: 260. 1908.
Fig. 20

Stromata composed of clusters of nearly free perithecia, ca. 2 mm diam, on short thin hairy stipes, the stipes sometimes projecting above stromata as apiculi; associated with subiculum. Externally black, internally white. Perithecia 0.5 mm diam. Ostioles papillate. Asci eight-spored, cylindrical, stipitate, ca. 165 μm total length X 9 μm broad, spore-bearing part ca. 107 μm , with apical ring bluing in Melzer's iodine reagent, inverted hat-shaped, 4.4 μm high X 2.9 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 16-17.6 X 6-7.3 μm , with germ slits variable, oriented with long axis of spore or oblique to long axis of spore, nearly spore-length or much less than spore-length. Anamorph unknown.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on palm, Samuels 1988, Sep 1985 (NY,BO,JDR).

NOTES: We have seen what is probably type material at K (Philippines: Copeland, E. D. 198, Lamao River, Bataan Prov., Luzon, on dead Calamus). It is generally like our material. Ascospores were not sought in the small collection, but were annotated as 16-19 X 7-8 μm . It seems much like X. heloidea Penz. & Sacc.; type material from

PAD is immature. It is likewise close to X. aburiensis (Dennis) D. Hawksw.

We were unable to initiate cultures from this material.

Xylaria cubensis (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 126. 1851.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 2019, Sep 1985 (NY,BO,JDR); Samuels 1953A, same data (NY,BO); Dumoga-Bone National Park, vic. 'Camp 1440', 0°37'N, 123°51'E, elev. 1140 m, on wood, Samuels 2096A, 3-5 Oct 1985 (NY).

NOTES: Xylaria cubensis has been collected from various locations around the world. It has been described, along with its anamorph, Xylocoremium flabelliforme (Schw.: Fr.) J. D. Rogers, by Rogers (1984). Of the above-cited collections, only 2096B was entirely typical of X. cubensis. Unfortunately, our material did not yield cultures.

Xylaria dealbata Berk. & Curt., J. Acad. Nat. Sci. Philadelphia (ser. 2) 2: 284. 1853.

Fig. 40

Stromata broadly clavate, obovate, or subglobose on short to long abrupt concolorous stipes, 3-6 cm total height X 2.5 cm diam, externally dull white to yellowish white with irregular orange areas, with black ostioles, internally at first with brownish to blackish flesh, ultimately hollow. Texture very hard. Surface smooth. Perithecia 0.7-1 mm diam. Ostioles punctate, barely raised. Asci eight-spored, cylindrical, stipitate, 200-350 μ m total length X 8-10 μ m broad, the spore-bearing part 180-190 μ m, with apical ring bluing in Melzer's iodine reagent, more or less cylindrical, 5.9-7.3 μ m high X 3.7-5 μ m broad. Ascospores nearly black, unicellular, long ellipsoid-inequilateral to fusoid or navicular with abrupt acute apices, smooth, 26-32.5 X (6-)6.6-7.3 μ m, with germ slit straight to undulating, 1/2-2/3 spore length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, at first velvety to floccose, white, turning brownish to blackish, then often overlain with fluffy white mycelium. Reverse buff to reddish brown.

Conidium-bearing regions developing on aging colonies, appearing as small, dense, whitish clusters of conidiophores or minute, pulvinate, 1-2 mm diam rudimentary stromata. Conidiophores upright in palisades, sparingly branched or unbranched except at the base, whitish-gray in mass. Conidiogenous cells terminal, cylindrical, 20-30 X 3.5-6 μm , bearing conical conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, narrow ellipsoid, with flattened bases indicating former points of attachment to conidiogenous cells, (14-)16-18 X 3-4 μm .

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 1940, Sep 1985 (NY); same locality and date, on recently fallen tree, Samuels 2026 (cultured), (NY,BO,JDR); Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on wood, Samuels 2125, 2137, 6,8 Oct 1985 (NY,BO,JDR); Dumoga-Bone National Park, vic. 'Hog's Back Camp', 0°35'N, 123°51'E, elev. 492 m, on wood, Samuels 2199, 30,31 Oct 1985 (NY,BO,JDR).

NOTES: In the opinion of Dennis (1961) Xylaria fockei (Miq.) Cooke should be used for this fungus. Indeed, types of X. dealbata, X. fockei, and X. kegeliana (Lev.) Fr. are from Surinam and Dennis (1961) suspected that these are conspecific. See also notes on Penzigia cranioides herein.

Cultures from one collection (Samuels 2125) bore conidia on old drying plates. The conidia are among the largest known among xylariaceous fungi. The collection which produced conidia, however, is not entirely typical of X. dealbata and further observations should be made on more typical material.

Xylaria aff. feejeensis (Berk.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser.3) 1, p. 128. 1851.

Stromata cylindrical with short or obsolete stipes, up to 4 cm total height X 2-3 mm broad, externally blackish brown, internally white. Texture not very hard. Surface roughened by ostioles and deep cracking. Perithecia 0.3 mm diam. Ostioles dome-shaped. Asci eight-spored, cylindrical, long-stipitate, ca. 130 μm total length X 6 μm broad, the spore-bearing parts 60-68 μm , with apical ring

bluing in Melzer's iodine reagent, inverted hat-shaped, $1.5\ \mu\text{m}$ high X $2.2\ \mu\text{m}$ broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, $8-9.5\ \mu\text{m}$ X $3.7-4.4\ \mu\text{m}$, with germ slit straight, spore-length or nearly so. Anamorph not observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', $0^{\circ}37'\text{N}$, $123^{\circ}51'\text{E}$, elev. 1140 m, on wood, Samuels 2088, 3-5 Oct 1985 (NY, JDR).

NOTES: This fungus is undoubtedly allied to X. feejeensis, X. curta, X. castorea, and X. luteostromata. See notes on this latter species.

Xylaria fissilis Ces. sensu Lloyd, Mycol. Notes 71, Mycol. Writings 7: 1247. 1924. Fig. 18

Stromata cylindrical on very short stipes, 1-3 cm high X 2-3 mm diam, unbranched or branched toward base, often cespitose, externally black with traces of juvenile brown, internally tan with blackish central core, eventually hollow and inrolled. Texture hard. Surface rugose. Perithecia 0.7-1 mm diam. Ostioles dome-shaped, inconspicuous. Asci eight-spored, cylindrical, long-stipitate, 120-190 μm total length X 6-8 μm wide, the spore-bearing part 80-90 μm , with apical ring bluing in Melzer's iodine solution, urn-shaped, 2-2.9 μm high X 2.2 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 13.3-14.7 X 4.4-5 μm , with germ slit straight to sigmoid, spore-length.

Colonies on oatmeal agar at ca. 20 C and under 12 hr fluorescent light covering 9 cm diam Petri plate in 2-3 wk, at first velvety, slightly zonate, white, becoming covered with blackish mycelium. Reverse pale reddish orange. Stromata up to 1 cm high X 1-2 mm diam produced at periphery of colony. No anamorphic structures observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Muajat, Danau Alia, $0^{\circ}45'\text{N}$, $124^{\circ}25'\text{E}$, elev. 1400 m, on wood, Samuels 2383, 2416, 26 Oct 1985 (NY, BO, JDR).

NOTES: Our material is much as described in Saccardo (1882) except that the ascospores are given as $20\ \mu\text{m}$ X $5\ \mu\text{m}$ on data furnished by M. C. Cooke. Lloyd (1924) described and illustrated Cesati's type material from Sarawak,

giving the ascospores as $14 \times 6 \mu\text{m}$. We have not seen type material, but follow Lloyd in considering it to be X. fissilis.

Xylaria grammica (Mont.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 128. 1851. Figs. 41-43

Stromata have been well-described by Dennis (1956, 1961). Asci eight-spored, cylindrical, long-stipitate, $260\text{--}280 \mu\text{m}$ total length $\times 6 \mu\text{m}$ broad, the spore-bearing part ca. $80 \mu\text{m}$, with apical ring bluing in Melzer's iodine reagent, rectangular to urn-shaped, $3\text{--}4 \mu\text{m}$ high $\times 2\text{--}2.5 \mu\text{m}$ broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, $(10.3\text{--})11.7\text{--}14 \times (4\text{--})4.5\text{--}5\text{--}(6) \mu\text{m}$, with straight germ slit full-length.

Colonies on oatmeal agar at ca. 20°C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, with mycelium at first with velvety and floccose sectors, white, at last blackening. Reverse orange buff. Conidium-bearing regions developing on aging colonies, these as small, dense clusters of conidiophores or small rudimentary stromata. Conidiophores upright in palisades, sparingly branched or unbranched except at the base, gray in mass. Conidiogenous cells terminal, cylindrical, $30\text{--}40 \times 5\text{--}6 \mu\text{m}$, bearing conical conidial secession scars. Conidia produced holoblastically in sympodial sequence. Conidia hyaline, smooth, narrow ellipsoid to clavate, guttulate, with flattened bases indicating former points of attachment to conidiogenous cell, $(16\text{--})17\text{--}21 \times (3\text{--})4\text{--}5 \mu\text{m}$.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, $0^\circ34'\text{N}$, $123^\circ57'\text{E}$, elev. 211 m, on wood, Samuels 1986, 2314, 2351 (cultured), Sep-Nov 1985 (NY,B0,JDR); same data Samuels 1945 (NY,B0).

NOTES: Xylaria grammica has been reported from tropical regions throughout the world. It is a distinctive fungus. Its anamorph as described here has the largest conidia known for any species of Xylaria.

Xylaria hypsipoda Massee, Bull. Misc. Inform. Royal Garden Kew 1899, p. 174. 1899.

Stromata globose to oblong, $1\text{--}4 \text{ mm}$ high $\times 1\text{--}3 \text{ mm}$ high, some with spike-shaped apical process, on long stipe $2\text{--}4 \text{ cm}$ high $\times$ less than 1 mm diam, externally dull brown

with whitish scales, internally white. Texture soft. Surface smooth; stipe hairy. Perithecia 0.3 mm diam. Ostioles inconspicuous. Asci eight-spored, the spores often arranged in biseriate manner, cylindrical to clavate, at least 160 μm total length $\times$ 12-20 μm broad, the spore-bearing part 70-100 μm , with apical ring bluing in Melzer's iodine reagent, urn-shaped, 5-8 μm high $\times$ 2.9-5 μm broad. Ascospores dark brown, unicellular, broad ellipsoid-inequilateral, smooth, 14-16(-17.6) $\times$ (6-)7-8 μm , with straight germ slit spore-length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 3-4 wk, at first cottony, white, becoming overlain in patches by brownish gray mycelium. Reverse grayish rose. Stromata produced infrequently at inoculation point or at periphery, clavate, unbranched or branched, 4-5 mm high $\times$ 2-3 mm broad, dark olive-gray with white to tan apices. No anamorphic structures observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on leaves, Samuels 1981, Sep 1985 (NY, BO, JDR).

NOTES: Our material is very much like a collection from K that probably is the type (Singapore, 1897). Measurements made by JDR on a few ascospores from that material are 14-15 $\times$ 7-8 μm . Saccardo (1902) gave the ascospore dimensions as 12 $\times$ 6-7 μm , probably based on the same material. We are uncertain about the origin of the difference between these sets of measurements. For the present, we assume the the author of the species either measured immature ascospores or made erroneous measurements.

Xylaria hypsipoda var. microspora J. D. Rogers, B. E. Callan & G. J. Samuels, var. nov. Figs. 15, 16

A varietate typica differt in ascosporis 8-9(-9.5) $\times$ 4-4.5(-6.6) μm , in diametro capitali fertilis minus quam 1 mm, et in altitudo stomatis ca. 1 cm vel minus.

Differs from typical variety in size of ascospores 8-9(-9.5) $\times$ 4-4.5(-6.6) μm , in diameter of fertile head less than 1 mm, and in height of stroma 1 cm or less.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers,

vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on leaf, Samuels 1954, Sep 1985 (HOLOTYPE, BO).

NOTES: This fungus in all respects appears to be a diminutive form of X. hypsipoda. It resembles a small X. aristata Mont. (Dennis, 1956) and is close to X. ocephala Penz. & Sacc. (Penzig & Saccardo, 1904). Dennis, in unpublished notes on Xylaria collections from the Saccardo herbarium, considered X. ocephala to be a synonym of X. aristata.

Xylaria juruensis P. Henn., Hedwigia 43: 262. 1904.

Stromata of nearly free perithecia on rachis 3 cm total length X 1-1.5 mm diam, externally black, internally white. Texture rather soft. Surface of stromata and stipe hairy. Perithecia 0.5-0.7 mm diam. Ostioles slightly papillate. Asci eight-spored, cylindrical, stipitate, 120-145 μ m total length X 10 μ m broad, spore-bearing part 85-87 μ m long, with apical ring bluing in Melzer's iodine reagent, rectangular, 4.4 μ m high X 2.9 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral to fusoid, usually with abrupt pinched apices, smooth, 16-17.6 X 6-6.6 μ m, with straight germ slit slightly less than spore-length. Anamorph not observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. Komangann, Limestone caves, 0°49'N, 124°12'E, elev. 400 m, on palm leaf midrib, Samuels 2367, 24 Oct 1985 (NY, JDR).

NOTES: Our material fits Henning's description and illustration well, except that he depicts the ascospores as somewhat crescentic with rounded ends. What is apparently type material at K (Ule, E. "herb Brasiliense," 2860, VI. 1901, Estado de Amazonas) has ascospores like those described herein. We thus feel justified in considering our material to be X. juruensis.

Unfortunately, our material did not yield cultures.

Xylaria luteostromata Lloyd, Large Pyrenomycetes 2, Mycol. Writings 5: 31.1919. Fig. 21

Stromata cylindrical to clavate, terete or flattened, on short or obsolete stipes, unbranched or occasionally branched, up to 5 cm high X 2-5 mm broad, cespitose, externally dull black, internally bright orange becoming

hollow with old age. Texture fairly hard. Surface rugose, warty, and with prominent ostioles. Perithecia 0.3-0.5 mm diam. Ostioles dome-shaped, prominent. Asci eight-spored, cylindrical, long-stipitate, 170 μ m total length X 7 μ m broad, spore-bearing part 50-70 μ m, with apical ring more or less wedge-shaped, minute. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 8.8-10.3 X 4.4-5 μ m, with germ slit straight, spore-length.

Colonies on oatmeal agar at ca. 20 C under 12 hr fluorescent light covering 9 cm diam Petri plate in 2 wk, at first velvety, white, becoming cottony and eventually densely felty, gray to brownish black. Sometimes sectoring into appressed white, yellow, or olive gray areas. Reverse tan to brownish black. No anamorphic structures observed.

SPECIMEN OBSERVED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on wood, Samuels 2003, Sep 1985 (NY,BO,JDR).

NOTES: Our material fits Lloyd's concept well. It is certainly allied to X. castorea Berk., X. feejeensis (Berk.) Fr., and X. curta Fr. Rogers & Samuels (IN PRESS) have described X. luteostromata var. macrospora J. D. Rogers & Samuels from New Zealand.

Xylaria cf melanax Ces., Myc. Born., p. 16. 1879.
Figs. 22,23,27,58,59

Stromata cylindric-fusoid, on short to long above-ground stipe, up to 10 cm total height X 4 mm diam, with long rooting base, externally white to yellowish white with black ostioles, internally black except whitish around perithecia. Texture hard. Surface roughened by close-set ostioles and wrinkles. Perithecia minute, barely 0.2 mm diam. Ostioles papillate. Asci eight-spored, cylindrical, long-stipitate, 50 μ m total length X 4 μ m broad, the spore-bearing part 25 μ m, with apical ring bluing in Melzer's iodine reagent, wedge-shaped, minute. Ascospores brown, unicellular, broad ellipsoid-inequilateral and flattened, smooth, 3.6-4.4 X 2.9 X 2.2 μ m, with round germ pore at mid-spore on narrow side. Anamorph not observed.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Hog's Back Camp', 0°35'N, 123°51'E,

elev. 492 m, on ground, Samuels 2469, 30,31 Oct 1985 (NY,BO,JDR).

NOTES: Our material is much like what is probably type material at K (leg. Beccari, Cesati "fung. Borneo"). The K material is black inside and out. Ours probably represents younger material prior to complete blackening. The curious flattened ascospores with median germ pore are virtually identical between the two collections. The germ pore appears sunken by scanning electron microscopy (Fig. 27). Moreover, most ascospores appear to bear a cellular appendage when viewed by scanning electron microscopy (Fig. 27), a feature that is nearly impossible to discern by light microscopy. Preliminary transmission electron microscopy indicates that the appendage contains a nucleus. The ascus ring resembles that of X. angulosa shown in Fig. 61.

Unfortunately, we were unable to obtain cultures from our material.

Xylaria nigripes (Klotz.) Cooke, Grevillea 11: 89. 1883.
Figs. 19,24,57

Stromata cylindrical, 4-6 cm long X 4-5 mm diam, on long rooting stipes 6-11 cm long, externally yellowish gray, tan, or gray, internally at first white, becoming blackened from center and eventually entirely black. Texture extremely hard. Surface plane except for occasional large wrinkles, roughened by ostioles. Perithecia ca. 0.2-0.3 mm diam. Ostioles papillate, prominent. Asci eight-spored, cylindrical, long-stipitate, 65-75 μm total length X 3-4 μm , spore-bearing part 28-30 μm long, with apical ring bluing in Melzer's iodine reagent, minute. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 4.4-5.9 X 2.2-2.9 μm , with straight germ slit spore-length.

Conidia from one stroma hyaline, obovate to nearly globose, 2.5-3 X 1.5-2.5 μm , with one end flattened. Conidiogenous cells not observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on ground, Samuels 1972, Sep 1985 (NY,JDR); same data 2031 (NY,BO,JDR).

NOTES: We have not seen type material of X. nigripes. Our material is much like a collection of T. Petch from

Ceylon (now Sri Lanka) in K (Petch, T. 3029, I.1910, Peradeniya). There are at K many collections labelled X. nigripes that bear little resemblance to this species. Various species listed in Sylloge Fungorum have long been considered as synonyms of X. nigripes. Some of them, in fact, will ultimately be shown to be distinct species. These Xylaria species associated with nests of ants and termites are in great need of investigation.

The ascus ring greatly resembles that of X. angulosa shown in Fig. 61.

We were unable to obtain cultures from our material.

Xylaria scruposa (Fr.) Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1: 127. 1851.

Stromata highly variable, cylindrical to clavate to highly irregular, on short or long stipes, up to 14 cm high (mostly 7 cm or shorter) X 1.5 cm broad (mostly 1 cm or less), externally dull black, internally white. Texture woody to somewhat carbonaceous. Surface usually rugose and with wart-like excrescences. Perithecia 0.5-0.7(-1) mm diam. Ostioles discoid, usually inconspicuous. Asci eight-spored, the spores sometimes arranged in a partially biseriate manner, cylindrical to clavate, long-stipitate, 220-235 μ m total length X 10-13 μ m broad, spore-bearing part 115-130 μ m, the apical ring bluing in Melzer's iodine reagent, more or less urn-shaped, 4.4-5.9(-7.3) μ m high X (2.9-)3.6-4.4(-5) μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral to crescentic with rounded to abruptly pinched apices, smooth, (16-)17.6-23(-25) X 6-9 μ m, with germ slits straight to sigmoid oriented oblique to the long axis, much less than spore-length.

Colonies on oatmeal agar at ca. 20 C under fluorescent light covering 9 cm diam Petri plate in 2-3 wk, at first floccose, white, becoming dark grayish brown. Reverse tan to pale brown. White cylindrical stromata ca. 1 cm high X 1-2 mm diam produced at periphery. No anamorphic structures observed.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, at confluence of Toraut and Tumpah Rivers, vic. Project Wallace Base Camp, 0°34'N, 123°57'E, elev. 211 m, on trunk of Livistonia sp., Samuels 1932, 1987, Sep-Oct 1985 (NY,BO,JDR); same data Samuels 1942 (NY,BO); same collecting data but on wood, Samuels 1953B, 2348 (NY); Dumoga-Bone National Park, Gn. Poniki, between 'Wien Camp' (0°28'N, 123°51'E, elev. 810 m) and 'Ice

Station Zebra' (0°26'N, 123°49'E, elev. 1520 m), on wood, Samuels 2290 (cultured), 19 Oct 1985 (NY,B0).

NOTES: Xylaria scruposa is a difficult taxon with which to deal. It has usually been defined as a member of the X. polymorpha group with ascospores averaging larger than those of X. longipes Nits. and smaller than those of X. polymorpha. According to Dennis (1958) type material of Sphaeria scruposa at Uppsala is sterile, very probably of another species. The traditional interpretation of X. scruposa is that of Montagne and, following Dennis, is accepted here.

Xylaria sp.

Stromata upright, apparently unbranched, with cylindric-clavate fertile part on abrupt long stipe, up to 8 cm high X 4 mm broad with the stipe making up one-half the total length, externally black, hollow. Texture horny-hard. Perithecia 0.2-0.3 mm diam. Ostioles strongly papillate and crowded, giving the otherwise smooth stromatal surface the texture of sandpaper. Asci eight-spored, cylindrical, poor condition in this material, with apical ring bluing in Melzer's iodine reagent, 2.2 μ m high X 1.5 μ m broad. Ascospores brown, unicellular, ellipsoid-inequilateral, smooth, 8-9.5 X 3.6-4.4 μ m, with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Poniki, vic. 'Ridgeway Camp', 0°29'N, 123°52'E, elev. 740 m, on ground, Samuels 2304, 19 Oct 1985 (NY,JDR).

NOTES: This fungus probably was associated with insects. Our material is depauperate and unworthy of intensive study. It might represent a new species.

Xylaria sp.

Figs. 25,26

Stromata upright, apparently unbranched, consisting of a subglobose to globose fertile head up to 3 mm diam on a long thin pubescent stipe, in total up to 2 cm high, externally at first bright yellow, becoming dull black, internally white. Fertile parts smooth. Prior to development of fertile parts, stipes bear coarse conical processes terminating in brown globose heads believed to be part of anamorph. Perithecia up to 1 mm diam, few per head.

Ostioles finely papillate. Asci eight-spored, the spores often arranged in partially biseriate manner, cylindrical to clavate, stipitate, 210-230 μm total length X 7-15 μm broad, spore-bearing part 130 μm , with apical ring bluing in Melzer's iodine reagent, urn-shaped, 6 μm high X 3 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral to fusoid, smooth, 23-26.5 X 7.3-9 μm , with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Hog's Back Camp', 0°35'N, 123°51'E, elev. 492 m, on petiole, Samuels 2454, 30,31 Oct 1985 (NY,BO,JDR).

NOTES: This fungus might represent a new species, but, owing to the small size of the collection and the suspicion that it is not fully mature, we await additional material before proceeding further. What appear to be anamorphic appendages on immature stromata seem much like those of Moelleroclavus P. Henn., long suspected of being a xylariaceous anamorph.

Xylaria sp.

Stromata upright, unbranched or branched, solitary or cespitose, consisting of cylindrical fertile parts bearing crowded, more or less naked perithecia, with terminal acute sterile apiculus, with short to long stipes, externally black, internally white. Texture fairly hard and brittle. Fertile parts and stipes tomentose. Perithecia 0.5-0.7 mm diam. Ostioles finely papillate. Asci eight-spored, cylindrical, stipitate, 185-200 μm total length X 10 μm broad, the spore-bearing part 120-135 μm , with apical ring bluing in Melzer's iodine reagent, more or less rectangular, 3.7-4.4 μm high X 2.9 μm broad. Ascospores brown, unicellular, ellipsoid-inequilateral, the ends rounded to acute, smooth, 14.7-17.6 X 5-6 μm , with germ slit slightly less than full-length.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Muajat, Danau Alia, 0°45'N, 124°25'E, elev. ca. 1400 m, on wood, Samuels 2386, 26 Oct 1985 (NY,JDR); same collecting data but on arecoid palm, Samuels 2405 (NY,BO,JDR).

NOTES: This fungus is very close to X. juruensis, differing primarily by the shape of the ascospore apices.

Additional collections might show it to be conspecific with X. juruensis.

Xylaria taxonomic species 1

Stromata upright or perhaps sometimes prostrate, apparently unbranched, consisting of a hair-like stipe up to 6 mm long bearing a head of more or less naked perithecia ca. 1 mm in diameter, externally black, internally white. Texture soft. Perithecia 0.1-0.2 mm diam. Ostioles papillate. Asci eight-spored, cylindrical, long-stalked, 115 μm total length X 7 μm broad, the spore-bearing part 65 μm long with apical ring bluing in Melzer's iodine reagent, rectangular, 2.9 X 2.9 μm . Ascospores nearly black, unicellular, broad ellipsoid-inequilateral, smooth, 8-9.5 X (4.4-)5-6 μm , with a noncellular (secondary) appendage 2-3 X 2-3 μm at each end, with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, Gn. Poniki, vic. 'Ridgeway Camp', 0°29'N, 123°52'E, elev. 740 m, on decaying dicot leaf, Samuels 2310, 19 Oct 1985 (NY,BO,JDR).

NOTES: The description is based upon a very small collection of this minute Xylaria. It might well be related to taxonomic species nos. 2 and 3 whose descriptions follow. The present fungus, however, is much less robust in comparison. In any case, we are reluctant to describe this fungus as a new species because of the small collection and the general taxonomic disorder of small leaf-inhabiting Xylaria species.

Xylaria taxonomic species 2.

Stromata upright, unbranched, consisting of a rachis up to 2 cm high X 0.5-1 mm thick bearing scattered naked perithecia, externally black, internally white. Texture soft. Rachis extending beyond perithecia to form short apiculus. Perithecia 0.2-0.3 mm diam. Ostioles papillate. Asci eight-spored, cylindrical, not measured, with apical ring bluing in Melzer's iodine reagent, 3 μm high X 1.5 μm broad. Ascospores brown, unicellular, broad ellipsoid-inequilateral, smooth, 9-10.3 X 4.4-5 μm , with a noncellular (secondary) appendage 1-2 μm long X 3 μm broad at each end, with straight germ slit full-length.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp Edwards', 0°35'N, 123°51'E, elev. 664 m, on leaf, Samuels 2055, 6,8 Oct 1985 (NY,BO, JDR).

NOTES: The small leaf-inhabiting Xylaria species are in urgent need of study on a worldwide basis. We are reluctant to formally erect new species at this time, especially based on small collections.

Xylaria taxonomic species 3

Stromata resembling taxonomic species 2 in gross morphology, naked perithecia, and appendaged ascospores. Differing primarily in larger size of ascospores, 11.7-13 X 4.4-5 μm , and ascus apical ring, 4.4 μm high X 2.9 μm broad. Terminal part of rachis of somewhat immature stromata bearing short concolorous branches almost at right angles, these probably part of the anamorphic state.

SPECIMEN EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, between 'Maddison's Camp' (0°36'N, 123°50'E, elev. 980 m) and 'Camp 1440' (0°37'N, 123°51'E, elev. 1140 m), on leaf, Samuels 2168, 5 Oct 1985 (NY,BO,JDR).

NOTES: This taxon is clearly related to Xylaria taxonomic species no. 2. Additional collections should clarify its status.

Xylaria telfairii Berk. & Fr., Nova Acta Regiae Soc. Sci. Upsal. (ser. 3) 1, p. 127. 1851.

Stromata as described by Dennis (1956, 1961). Asci eight-spored, cylindrical, long-stipitate, 250-260 μm total length X 12 μm broad, spore-bearing part 105-110 μm , with ascus apex bluing in Melzer's iodine reagent, rectangular to somewhat urn-shaped, 5 μm high X 3.7 μm broad. Asco-spores brown, unicellular, ellipsoid-inequilateral to crescentic with apices rounded or pinched, smooth, 16-19 X 6.6-7.3 μm , with germ slit obliquely oriented, straight to sigmoid, much less than spore-length. Anamorph unknown.

SPECIMENS EXAMINED: INDONESIA: North Sulawesi, Dumoga-Bone National Park, vic. 'Camp 1440', 0°37'N, 123°51'E, elev. 1140 m, on wood, Samuels 2084 (immature), 2096A (see notes), 3-5 Oct 1985 (NY); Dumoga-Bone National Park, between 'Maddison's Camp' (0°36'N, 123°50'E, elev. 980 m)

and 'Camp 1440' (0°37'N, 123°51'E, elev. 1140 m), on wood, Samuels 2154 (immature), 5 Oct 1985 (NY,JDR); Dumoga-Bone National Park, Gn. Poniki, between 'Wien Camp' (0°28'N, 123°51'E, elev. 810 m) and 'Ice Station Zebra' (0°26'N, 123°49'E, elev. 1520 m), on wood, Samuels 2288, 19 Oct 1985 (NY,BO,JDR).

NOTES: Xylaria telfairii has been reported from various tropical regions of the world. Dennis (1956, 1961) has listed a number of probable synonyms, among them X. enterogena (Mont.) Fr. JDR has been uncertain about the relationship of X. enterogena to X. telfairii, although unpublished cultural data from South American fungi tends to support Dennis. Specimen 2096A looks more like X. enterogena than typical X. telfairii. Unfortunately, we were unable to obtain cultures from our collections.

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ECHIDNOCYMBIUM (BIATORACEAE), A NEW LICHEN GENUS
FROM SOUTHERN AFRICA

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ABSTRACT

A new lichen genus, *Echidnocymbium*, is described from the south-western Cape, South Africa, on maritime rocks. The genus is represented by a single conspicuous species, *E. speciosum*. The affinities of the genus are discussed.

ECHIDNOCYMBIUM Brusse, *gen. nov.*

Lichen ad Biatoraceas (Ascomycetes, Lecanorales) pertinens. Thallus crustosus, saxicola. *Apothecia* lecanorina, substipitata. *Paraphyses* septatae, ramosae, capitatae, in gelatina leviter inclusae. *Asci* tholis J+ caeruleis ut in iconem (figura 2) illustrati. *Ascosporae* octonae, hyalinae, simplices, ellipsoideae. *Pycnidia* superficialia, atra, sphaerica. *Pycnidiosporae* hyalinae, rigidae, longe aciculares.

Typus: *Echidnocymbium speciosum* Brusse.

Lichen belonging to the Biatoraceae (Ascomycetes, Lecanorales). Thallus crustose, saxicolous. *Apothecia* lecanorine, substipitate. *Paraphyses* septate, branched, capitate, lightly gelatinized. *Asci* with tholus J+ blue as in illustration (figure 2), eight-spored. *Ascospores* hyaline, simple, ellipsoid. *Pycnidia* superficial, black, spherical. *Pycnidiospores* hyaline, long rigid needles.

ECHIDNOCYMBIUM SPECIOSUM Brusse, *sp. nov.*

Thallus crustosus, saxicola, cremeus, tartareus, usque ad 5 cm diametro, 0,5–1,0 mm crassus, cum hypothallo atro limitatus. *Superficies* crenea, rimose subareolata, omnino papillata vel granulosa, granulis 50–100 μ m diametris. *Cortex superior* non bene evolutus, 10–20 μ m crassus, dense inspersus, anticlinate plectenchymatus. *Stratum gonidiale* 50–100 μ m crassum, algis *Trebouxii*s, 4–15 μ m diametris. *Medulla* alba; hyphae parietibus crassis, septatae, 3,0–4,2 μ m crassae, luminibus 0,9–1,7 μ m crassis. *Apothecia* numerosa, substipitata, lecanorina, usque ad 4 mm diametris, subareolata, marginibus involutis, papillatis vel granulatis. *Excipulum* hyalinum, 15–30 μ m crassum, J-, periclinate prosoplectenchymatum, cellulis ellipsoideis vel longe ellipsoideis. *Hypothecium* hyalinum, inspersum, 50–60 μ m crassum, J+ caeruleum, cellularum isodiametrar-

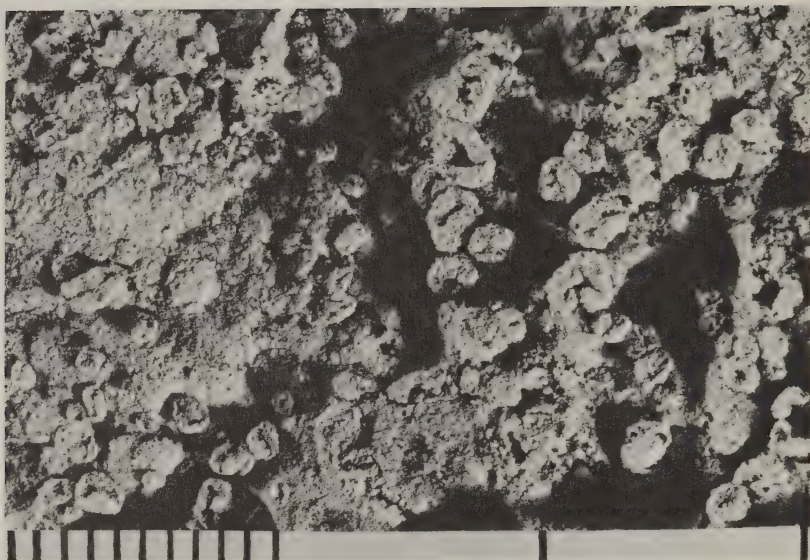


Fig. 1. *Echidnocymbium speciosum* Brusse, habit photograph. F. Brusse 2891, holotype. Scale in mm.

um, 3,5–7,0 μm diametris, compositum. *Hymenium* hyalinum, 40–55 μm altum, J+ caeruleum. *Paraphyses* ramosae, leviter conglutinatae, 2,5–3,0 μm crassae, capitatae; capita 4–5 μm crassa, granulis tecta. *Asci* clavati, 45–50 $\times$ 11–13 μm , cum tholis J+ caeruleis (figura 2). *Ascospores* octonae, hyalinae, simplices, longe ellipsoideae, 9–13 $\times$ 5–6,5 μm . *Pycnidia* sphaerica, atra, superficialia, 150–200 μm diametris. *Pycnidiospores* hyalinae, aciculares (rigidae), 12–30 $\times$ 1 μm . *Thallus* atranorinum et/vel chloro-atranorinum, et acidum sticticum continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE, Cape Columbine, on maritime granite rocks. F. Brusse 2891, 30.iv.1981 (PRE, holo-; COLO, LD, iso-). Fig. 1.

Thallus crustose, saxicolous, cream, tartareous, up to 5 cm across (but growing in large patches containing many individuals), 0,5–1,0 mm thick, lined with black hypothallus. *Surface* cream, rimose subareolate, totally papillate to granular, granules 50–100 μm diam. *Upper cortex* not well developed, 10–20 μm thick, densely granular interspersed, anticlinally plectenchymatous. *Algal layer* 50–100 μm thick, clustered, algae *Trebouxia*, 4–15 μm diam. *Medulla* white, hyphae thick-walled, septate, 3,0–4,2 μm thick, lumens 0,9–1,7 μm thick. *Apothecia* numerous, substipitate, lecanorine, up to 4 mm across, suburceolate, margins involute, papillate to granular. *Exciple* hyaline, 15–30 μm thick, J-, periclinally prosoplectenchymatous, cells ellipsoid or long ellipsoid. *Hypothecium* hyaline, granular interspersed, 50–60 μm thick, J+ blue, composed of isodiametric cells, 3,5–7,0 μm diam. *Hymenium* hyaline, 40–55 μm high, J+ blue. *Paraphyses* branched, lightly conglutinate, 2,5–3,0 μm thick, capitate; heads 4–5 μm thick, covered with granules. *Asci* clavate, 45–50 $\times$ 11–13 μm , eight-spored, tholus J+ blue (fig. 2). *Ascospores* hyaline, simple, long-ellipsoid, 9–13 $\times$ 5–6,5 μm . *Pycnidia* spherical, black, superficial, 150–200 μm diam. *Pycnidiospores* hyaline needles (rigid), 12–30 $\times$ 1 μm .

Chemistry: atranorin and/or chloroatranorin, and stictic acid present (one or two unidentified terpenes present as well).

Echidnocymbium speciosum resembles a very robust *Trapelia* in habit. The thecium sometimes tears away from the thalline exciple on sectioning, which is quite characteristic of *Trapelia*. These similarities are only superficial, however, because the tholus of this new genus differs in the iodine reaction — being most strongly amyloid in a band just above the plasmalemma of the submature ascus (fig. 2). *Trapelia* is J- or J+ very pale blue, without any internal amyloid structures in the tholus (Hertel 1969, 1970, 1977). The paraphyses are clearly capitate in *Echidnocymbium* (fig. 2), whereas this is not so in *Trapelia* (Hertel 1969, 1970, 1977). The Trapeliaceae often (always?) contain the simple tridepside gyrophoric acid (Hertel & Leuckert 1969, Coppins & James 1984) whereas this lichen contains the highly oxidised β -orcinol depsidone, stictic acid.

This new genus is best placed in the Biatraceae, as circumscribed by Hafellner (1984). The figures illustrating the tholi in that work always include an ocular chamber, but this structure merely represents a narrower extension of the ascial cytoplasm into the tholus. Thus the sides and top of the ocular chamber are completely equivalent to the base of the tholus. The ocular chamber is not always present in the tholus of lichens that produce them, and there often is an ocular chamber present in this new genus (but figure 2 is an example of a tholus without one). Those tholi with ocular chambers in this new genus, have them lined with deeply blue-staining tholus material, similar to those illustrated by Hafellner (1984), but the deep-blue lining also extends over most of the bottom of the tholi in this case. *Echidnocymbium* is therefore placed in the Biatraceae.

This lichen is presently known only from the type locality at Cape Columbine, just north of Saldanha Bay, on the west coast of South Africa, where it forms conspicuous large cream patches on maritime rocks above the *Caloplaca* zone.

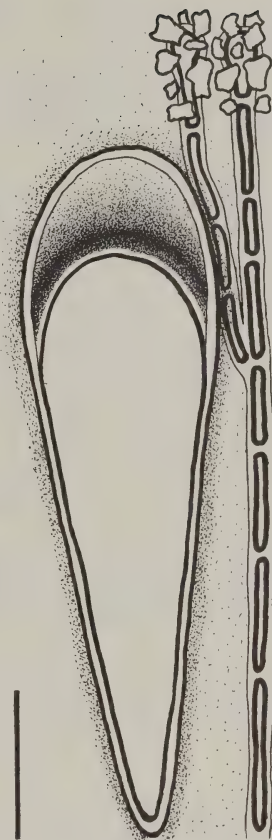


Fig. 2. *Echidnocymbium speciosum* Brusse, ascus and paraphysis, stained in Lugol's iodine solution. F. Brusse 2891, holotype. Bar = 10 μ m.

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EREMASTRELLA MONTANA (PSORACEAE), A NEW LICHEN SPECIES FROM THE DRAKENSBERG, SOUTH AFRICA

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ABSTRACT

A new species of *Eremastrella* Vogel (Psoraceae), *E. montana* Brusse, is described from high altitudes in the Drakensberg, South Africa, on shallow soil over rock in seepage areas. The affinities and chemistry of the species is discussed.

EREMASTRELLA MONTANA Brusse, *sp. nov.*, thallo ut in *E. crystallifera* (Tayl.) G. Schneid., sed squamulis parvioribus, superficiebus minus crystallinis, marginibus albis et farinose sorediatis, acidum norsticticum continente, et hypotheciis crassioribus, differt.

Thallus squamulosus, brunneus, terricola, usque ad 10 cm diametro. *Squamulae* umbrinae vel glandulaceae, marginibus albis, farinose sorediatis, 2–8 mm diametro, 500–800 μm crassae, concavae, peltatae. *Superficies* undulata vel obtuse crystallina, marginibus albis, cum soraliis linearibus, pallide griseis. *Stratum epinecrale* (crystalla) usque ad 130 μm crassum. *Cortex superior* hyalinus, 50–300 μm crassus, hypharum anticlinatarum, cellulis brevibus, parietibus tenuibus, conglutinatarum compositus. *Stratum gonidiale* interruptum, columnare, 30–300 μm altum (paginam non attingens); algae Chlorococcaleae, 4–15 μm diametro. *Medulla* alba, 180–370 μm crassa, hyphis 1.7–3.0 μm crassis. *Cortex inferior* purpureus, circa 20 μm crassus, paraplectenchymatus, cellulis 3–6 μm diametro. *Pagina inferior* atra, erhizinata. *Apothecia* atra, leviter pruinosa, lecideina, usque ad 4 mm diametro. *Excipulum* purpureum, ut in *E. crystallifera*. *Hypothecium* 40–65 μm crassum, brunneo-maculatum, hypharum anticlinatarum, cellulis brevibus, parietibus tenuibus, conglutinatarum compositum, J-. *Hymenium* 60–70 μm altum, pallide aeruginosum, interdum pallide purpureum, interdum cinereum, interdum pallide brunneum, J+ caeruleum. *Paraphyses* conglutinatae, septatae, leviter ramosae, 0.9–1.8 μm crassae. *Asci* clavati, 45–60 $\times$ 12–16 μm , tholis J+ caeruleis (ut in *E. crystallifera*). *Ascospores* octonae, hyalinae, simplices, ellipsoideae, 9–11 $\times$ 6–7.5 μm . *Pycnidia* non visa. *Thallus* acidum norsticticum et materias ignotas (ut in *E. crystallifera*) continens.

TYPUS.—SOUTH AFRICA, CAPE PROVINCE, 3028 (Matatiele): 65 km N of Maclear, summit of Naudé's Nek, on soil near low rock exposures in seepage areas, on summit plateau, alt. 2,500 m (—CA). *F. Brusse* 4588, 1986.01.26 (PRE, holo-; B, BM, COLO, E, LD, LG, MEL, S, UPS, US, iso-). Figura 1.

Thallus as in *Eremastrella crystallifera* (Tayl.) G. Schneid., except squamules smaller, surfaces less crystalline, margins white and farinose-sorediate, containing norstictic acid and hypothecium thicker.

Thallus squamulose, brown, terricolous, up to 10 cm across. *Squamules* brown to light brown, margins white, farinosely sorediate, 2–8 mm across, 500–800 μm thick, concave, peltate. *Upper surface* rippled to bluntly crystalline, margins white, with linear, pale grey soralia. *Upper cortex* hyaline, 50–300 μm thick, composed of conglutinate, anticlinal, short-celled, thin-walled hyphae. *Epinecral layer* (crystals) up to 130 μm thick. *Algal layer* broken, columnar, 30–300 μm high (not reaching surface); algae Chlorococcalean, 4–15 μm diam. *Medulla* white, 180–370 μm thick, hyphae 1.7–3 μm thick. *Lower cortex* purple, around 20 μm thick, paraplectenchymatous, cells 3–6 μm diam. *Lower surface* black, erhizinate. *Apothecia* black, lightly pruinose, lecideine, up to 4 mm across. *Exciple* purple, as in *E. crystallifera*. *Hypothecium* 40–65 μm thick, brown-blotched, composed of conglutinate, anticlinal, short-celled, thin-walled hyphae, J–. *Hymenium* 60–70 μm high, pale bluish- to bottle-green, sometimes mauvish, pale grey, or pale brown, J+ blue. *Paraphyses* conglutinate, septate, lightly branched, 0.9–1.8 μm thick. *Asci* clavate, eight-spored, 45–60 $\times$ 12–16 μm , tholus J+ blue (as in *E. crystallifera*). *Ascospores* hyaline, simple, ellipsoid, 9–11 $\times$ 6–7.5 μm . *Pycnidia* not seen. *Chemistry*: norstictic acid and unidentified substances (as in *E. crystallifera*).

Etymology: The specific epithet is derived from the latin stem, *mont*, of *montes* meaning mountains, and the latin adjectival suffix *-ana*, which indicates position, connection or possession by. Hence *montana* means 'from the mountains', and indicates the macrohabitat of this new species.

This second species in the previously monotypic genus *Eremastrella*, is related to *E. crystallifera* (Tayl.) G. Schneider (1979), and resembles it in several important characters. The apothecia of both species are very similar and only differ in that those of *E. montana* have distinctly thicker hypothecia (40–65 μm , as opposed to 5–20 μm in *E. crystallifera*). The ascial tholus of this species is similar to that of *E. crystallifera*, and the latter's is illustrated by Schneider (1979) and Hafellner (1984). However the dark blue cylinder in the tholus (along the only axis of symmetry) in Lugol's iodine solution, is of greater bore than is illustrated by these two authors.

The structure of the thalline squamules are very similar, but the epinecral bosses (crystals) are never as large as those of *E. crystallifera*. The margins of the squamules of *E. montana* are white, and are actually the undersurface turned up at the margins. Although the undersurface is usually black throughout in both species, it does occasionally become white near the margins in *E. crystallifera*. The margins of *E. montana* are always neatly rounded-off, and what appear to be farinose soredia are produced. The soralia are grey in colour, and linear, but the surface appears quite stable and compact for such a structure. On the other hand, the margins of *E. crystallifera* are irregular and appear to be the result of the breaking-off of the outer parts of the squamule, between the large crystals (epinecral bosses) which represent weak points in the squamule. The white parts irregularly exposed at the margins are therefore mostly the exposed medulla.

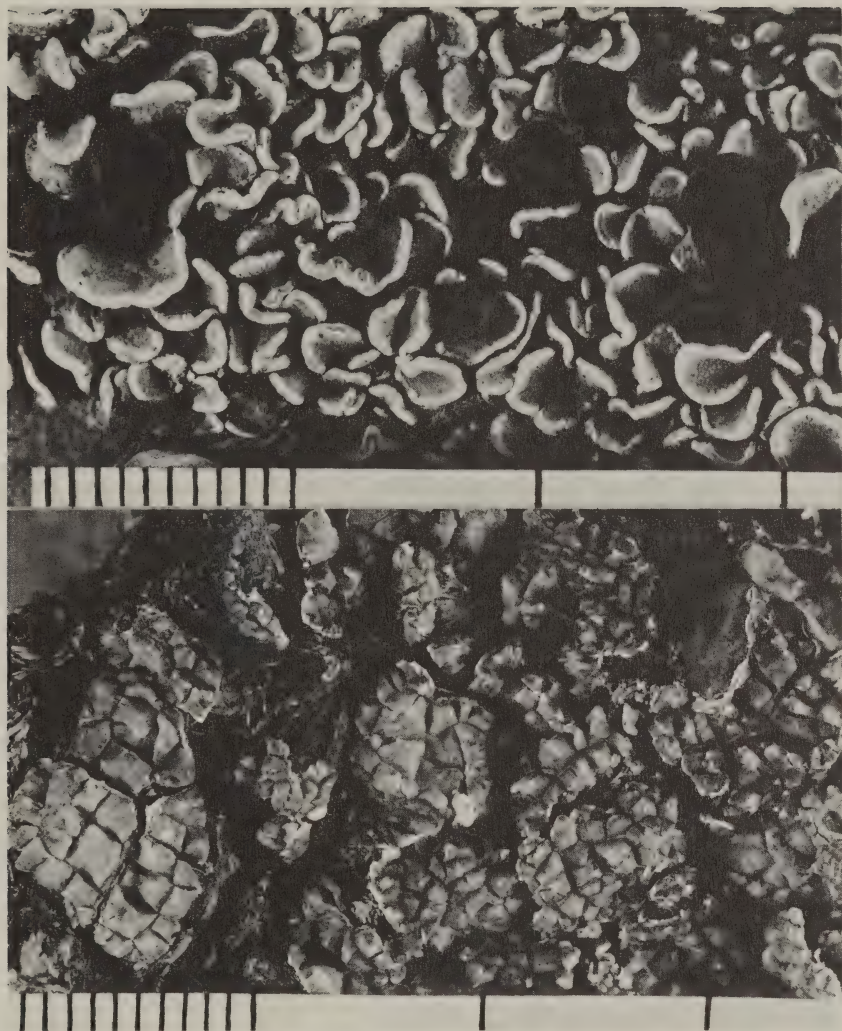


Fig. 1. *Eremastrella montana* Brusse, habit. *F. Brusse 4588*, holotype. Scale in mm.

Fig. 2. *Eremastrella crystallifera* (Tayl.) G. Schneid., habit. *F. Brusse 4513*. Scale in mm.

E. montana does not break-off at the margins in this manner, being entire. An illustration of *E. crystallifera* is presented in Filson and Rogers (1979) and figure 2.

The chemistry of the two species also differ. *E. montana* contains all the unknown substances found in *E. crystallifera* (which show up without treatment in longwave ultra-violet light, but do not quench the plate fluorescence in shortwave ultra-violet light), but contains norstictic acid and an unidentified aliphatic acid as well. When moist, norstictic acid oxidises in air to a red substance, in a similar way to salacinic acid, and *E. montana* specimens appear more orange than they are in the natural state, due to this fact.

Although both species are found at high altitudes in the Drakensberg on dark coloured soils derived from basalt, in seepage areas, the microhabitats of the two species differ. *E. crystallifera* grows on relatively deep soil between small sedges or other plants in or near seepage areas, and is quite difficult to see, being a very similar colour to the soil on which it grows. *E. montana*, on the other hand, grows in seepage areas in exposed positions near rock, and is highly visible. The soil on which it grows is shallow, with rock lying closely beneath. Both species have been observed to grow in places in which the surrounding surface is horizontal to vertical, but always in seepage areas.

Eremastrella is placed in the Psoraceae, because the amyloid structure in the tholus is similar to that of *Psora*, the type of this family. In fact the structure of the exciple and hypothecium is not that much different from *Psora* (excluding colour, and quantitative differences) and the asci are equally primitive in both genera, having thickened apices which are amyloid. However the paraphyses of *Psora* are well differentiated, being unbranched (simple) and capitate, and are also not strongly gelled. The paraphyses of *Eremastrella* are poorly differentiated, being branched and ecapitate, and are also strongly embedded in a gelatinous matrix which is lightly coloured (not as illustrated by Hafellner, 1984).

Eremastrella montana is presently known only from high altitudes in the Drakensberg, and is restricted to southern Africa. *E. crystallifera* is more widespread in southern Africa, and is also known from Australia (Filson & Rogers 1979), where it was first discovered (Taylor 1847).

ADDITIONAL SPECIMEN EXAMINED.—SOUTH AFRICA, NATAL, 2828 (Bethlehem): 31 km S of Phuthaditjhaba, summit of Mont aux Sources, Western Butress, summit plateau, on soil near rock in seepage areas, on gentle S slope, alt. 3080 m (—DD). F. Brusse 4518, 1986.01.21 (ABSL, ALA, B, BG, BM, C, CAN, COLO, DAOM, DAV, DS, DUKE, E, F, FH, G, GB, H, KRA, KUO, LD, LE, LISU, M, MEXU, MICH, MSC, MVM, NMW, NY, O, OULU, PC, POZ, PRE, S, SD, TUR, UBC, UC, UPS, US, VT, W, WIS, WS, WTU (Lichenes Exsiccati COLO 687)).

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THE TAXONOMIC VALUE OF PHENOLOXIDASE TESTS FOR SEPARATING
PEZIZA AND PLICARIA (PEZIZALES)

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It was noted in a survey of substrate hydrolysis patterns of species of Pezizales (Egger 1986) that *Peziza* isolates reacted differently to *p*-cresol, a substrate of the phenoloxidase enzyme tyrosinase. Additional isolates were tested to determine the taxonomic value of phenoloxidase tests in separating *Peziza* and *Plicaria* species. Results indicate that oxidation of tyrosinase substrates helps to distinguish *Plicaria* from *Peziza* and the genus concept of *Plicaria* may have to be modified to include elliptical-spored species.

Plicaria, in the modern sense, is primarily distinguished from *Peziza* by its spherical ascospores. Korf (1960) provided a detailed history of the name *Plicaria*. He argued that the formation of spherical ascospores was not a significant generic character and merged *Plicaria* with *Peziza*. However, Dissing and Pfister (1981) summarized the alternative argument that *Plicaria* forms a natural grouping of species and while spherical ascospores may not be critical, they are correlated with dark-colored apothecial pigments, an excipulum containing globose and hyphal elements, paraphyses that are often encrusted or embedded in a matrix, production of *Chromelosporium* anamorphs, and a carbonicolous habit.

METHODS

Most isolates tested were cultured by germination of ascospores harvested from fresh ascomata on inverted petri dishes containing agar medium. A few cultures (KNE 281, 999, and A01079) were isolated by germinating ascospores from dried ascomata that were rehydrated in water or 50% ethanol. KNE 281 was initially isolated in 1983 and reisolated in 1986. Numbers prefixed by an "A" were obtained from the culture collection at DAOM (Mycology Section, BRC, Agriculture Canada, Ottawa K1A 0C6), except A01308 and A01503 which were isolated from unburnt soil, and A01706 which was obtained from Dr. J.W. Paden. All cultures were maintained at 5 C on potato carrot agar slant tubes. Subcultures and voucher specimens are available from the author upon request.

Production of phenoloxidase enzymes was detected by biochemical reaction of enzyme substrates with mycelial cultures. The test substrate reagents were: syringaldazine (5 mM in 95% ethanol), *p*-cresol and 1-naphthol (100 mM in 95% ethanol), and L-tyrosine (50 mM in distilled water). Two replicates of each isolate were grown on Difco potato dextrose agar (pH 5.5). Tests were conducted when the colony covered 2/3 to 7/8 of the plate or at 28 days for slow-growing isolates. Tests were performed by removing two 5 mm diameter agar plugs (1 cm from the colony center and 0.5 cm from the colony edge) on each of 4 radii. One or two drops of enzyme substrate were added to the wells with a different test on each radius. As recommended by Marr *et al.* (1986), the L-tyrosine solution was heated in a boiling water bath prior to application. A positive reaction was indicated by a red color change for syringaldazine, purple for 1-naphthol, orange-brown for *p*-cresol, and brown for L-tyrosine. Color changes were observed within 30 min for syringaldazine, and at 3 h and 24 h for 1-naphthol, *p*-cresol and L-tyrosine. Tests were scored as no reaction (-), weak reaction (+), and strong reaction (++). Results are summarized in Table 1.

Taxonomic Treatment

I am using the names *Peziza praetervisa*, *P. petersii*, *Plicaria endocarpoides* and *P. trachycarpa* in the sense of Rifai (1968) and *Peziza violacea* in the sense of Dennis (1981, as figured in Rifai 1968). However, according to Svrček (1976, 1977) the correct name for *Peziza violacea* is *P. lobulata* (Vel.) Svrček and for *Peziza praetervisa* is *P. subviolacea* Svrček. The name *Peziza tenacella*?, as described by Rifai (1968), is used for a species similar to *P. praetervisa* but with smooth spores and more greatly enlarged paraphyses. *Peziza* sp. #1 is a smooth-spored species from soil and rotting vegetation in a marshy area which produces an *Oedocephalum* anamorph in culture. It is similar to *P. linteicola* Phill. & Plow. (sensu Dennis 1981). *Peziza* sp. #2 is an elliptical-spored species similar to *P. ostracoderma*, but has strongly warted, non-reticulate spores (similar to *Plicaria trachycarpa*). Other species concepts follow those of Dennis (1981).

DISCUSSION

Some elliptical-spored species that have been maintained in *Peziza* were atypical compared to the other *Peziza* isolates because they produced extracellular tyrosinase. The strong reaction of *P. ostracoderma* and *Peziza* sp. #2 to *p*-cresol suggests a strong affinity between these species and the spherical-spored *Plicaria* species. This relationship is corroborated by the observation that both these species produce *Chromelosporium* anamorphs in culture. *Peziza atrovinosa* reacted less strongly with *p*-cresol, but generally reacted strongly with L-tyrosine. This also suggests an affinity to *Plicaria* but an anamorph has not been

observed in this species. A study is currently underway to assess teliomorph characters in *Plicaria* (Pfister and Egger, in progress). If correlating characters are found, it may be necessary to expand the genus concept of *Plicaria* to include noncarbonicolous, elliptical-spored species that produce *Chromelosporium* anamorphs.

The value of phenoloxidase tests in taxonomy has been reviewed by Marr *et al.* (1986) and a more detailed discussion of their possible biological role can be found in Egger (1986). Tests were quite consistent between isolates of the same species, but there were some differences. First, monospore isolates typically reacted less strongly than polypore isolates. This suggests that presence of multiple genotypes improves substrate oxidation. Secondly, older cultures typically reacted less strongly than recently isolated cultures. This indicates that cultures lose ability to produce phenoloxidases over time when maintained on slant tubes at 5 C. These observations should be taken into account when interpreting results of phenoloxidase tests. Lastly, the syringaldazine reaction was highly dependent upon the location of the test in the colony (*i.e.* near the center or near the margin) and also varied with the age of the culture. The other tests were not as sensitive to these variations.

ACKNOWLEDGMENTS

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PHENOLOXIDASE TEST REACTIONS

Table 1

Name	Number	Isolate ²	Isolation Date	Place ³	Oxidase Test ¹			
					Cr	Ty	Sy	Na
<i>Peziza arvernensis</i> Boud.	2058	M1	1986	Ont.	-	-	-	-
<i>Peziza atrovinosa</i> Cooke	2107	P1	1986	MN	+	++	-	-
<i>Peziza atrovinosa</i> Cooke	2107	P2	1986	MN	+	+	-	-
<i>Peziza atrovinosa</i> Cooke	2107	P3	1986	MN	+	++	-	-
<i>Peziza atrovinosa</i> Cooke	2125	P1	1986	Qué.	+	+	-	-
<i>Peziza atrovinosa</i> Cooke	2125	P2	1986	Qué.	+	+	-	-
<i>Peziza badiocnifusa</i> Korf	2073	M2	1986	Qué.	-	-	-	-
<i>Peziza badiocnifusa</i> Korf	2073	P1	1986	Qué.	-	-	-	-
<i>Peziza cerea</i> Sow.	2113	M1	1986	Qué.	-	-	-	-
<i>Peziza cerea</i> Sow.	2113	P1	1986	Qué.	-	-	-	-
<i>Peziza cerea</i> Sow.	2015	M1	1985	B.C.	-	-	-	-
<i>Peziza cerea</i> Sow.	2015	P1	1985	B.C.	-	-	-	-
<i>Peziza domiciliana</i> Cooke	A01507		1983	Ont.	-	-	-	+
<i>Peziza echinospora</i> Karst.	326		1979	Ont.	-	-	++	++
<i>Peziza echinospora</i> Karst.	2136	P1	1986	Qué.	-	-	+	+
<i>Peziza</i> sp. #1	533		1980	Alb.	-	-	+	+
<i>Peziza</i> sp. #1	644		1980	Alb.	-	-	+	+
<i>Peziza ostracoderma</i> Korf	2098	P1	1986	Qué.	++	+	++	++
<i>Peziza ostracoderma</i> Korf	2138	M1	1986	Qué.	+	+	++	++
<i>Peziza ostracoderma</i> Korf	2138	P1	1986	Qué.	++	++	++	++
<i>Peziza ostracoderma</i> Korf	A01471		1979	Qué.	+	-	-	+
<i>Peziza ostracoderma</i> Korf	A01525		1978	Alb.	++	-	+	++
<i>Peziza</i> sp. #2	1056	T1	1984	B.C.	++	+	++	++

Table 1. (Continued)

Name	Number	Isolate ²	Isolation Date	Place ³	Oxidase Test ¹			
					Cr	Ty	Sy	Na
<i>Peziza petersii</i> Berk.	A01079		1980	B.C.	-	-	-	+
<i>Peziza praetervisa</i> Bres.	305		1979	Ont.	-	-	-	-
<i>Peziza praetervisa</i> Bres.	866	M1	1982	B.C.	-	-	+	++
<i>Peziza praetervisa</i> Bres.	882		1982	B.C.	-	-	+	++
<i>Peziza praetervisa</i> Bres.	996	M1	1983	B.C.	-	-	+	+
<i>Peziza praetervisa</i> Bres.	2043	M1	1985	B.C.	-	-	+	++
<i>Peziza praetervisa</i> Bres.	2043	P1	1985	B.C.	-	-	++	++
<i>Peziza praetervisa</i> Bres.	2060	M2	1986	Qué.	-	-	++	++
<i>Peziza praetervisa</i> Bres.	2078	P1	1986	Qué.	-	-	++	++
<i>Peziza praetervisa</i> Bres.	321		1979	Ont.	-	-	-	-
<i>Peziza tenacella</i> ? Phill.	2061	M1	1986	Qué.	-	-	-	-
<i>Peziza varia</i> (Hedw.) Fr.	2061	M2	1986	Qué.	-	-	-	-
<i>Peziza varia</i> (Hedw.) Fr.	2061	P1	1986	Qué.	-	-	-	-
<i>Peziza varia</i> (Hedw.) Fr.	353		1980	Ont.	-	-	-	-
<i>Peziza violacea</i> Pers.	965	P1	1983	B.C.	-	-	-	+
<i>Peziza violacea</i> Pers.	976	P1	1983	B.C.	-	-	+	++
<i>Peziza violacea</i> Pers.	1075		1984	B.C.	-	-	++	++
<i>Peziza violacea</i> Pers.	1082	P1	1984	B.C.	-	-	++	++
<i>Peziza violacea</i> Pers.	1094	M1	1984	B.C.	-	-	+	+
<i>Peziza violacea</i> Pers.	1094	P1	1984	B.C.	-	-	++	++
<i>Peziza violacea</i> Pers.	1112	M1	1984	B.C.	-	-	-	+
<i>Peziza violacea</i> Pers.	1122	P1	1984	B.C.	-	-	-	+
<i>Peziza violacea</i> Pers.	2040	M1	1985	B.C.	-	-	-	+
<i>Peziza violacea</i> Pers.	2040	P1	1985	B.C.	-	-	+	++
<i>Peziza violacea</i> Pers.	2042	P1	1985	B.C.	-	-	+	++

Table 1. (Continued)

Name	Number	Isolate ²	Isolation		Cr	Oxidase Test ¹		
			Date	Place ³		Ty	Sy	Na
<i>Plicaria endocarpoides</i> (Berk.) Rifai	884	M1	1982	B.C.	++	++	-	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	884	P1	1982	B.C.	++	+	-	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	887	M1	1982	B.C.	++	+	+	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	968	P1	1983	B.C.	++	++	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	984	M1	1983	B.C.	++	+	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	985	P1	1983	B.C.	++	++	+	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	1038	M1	1983	B.C.	++	+	-	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	1038	P1	1983	B.C.	++	+	+	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	1066	P1	1984	B.C.	++	++	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	1070	P1	1984	B.C.	++	+	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	1076	P1	1984	B.C.	++	+	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	2044	M1	1985	B.C.	++	++	+	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	2044	M2	1985	B.C.	++	++	+	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	2044	P1	1985	B.C.	++	++	++	++
<i>Plicaria endocarpoides</i> (Berk.) Rifai	A01308		1982	B.C.	++	++	-	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	A01503		1982	B.C.	++	+	+	+
<i>Plicaria endocarpoides</i> (Berk.) Rifai	281		1983	Ont.	+	-	-	-
<i>Plicaria trachycarpa</i> (Curr.) Boud.	281	P1	1986	Ont.	++	+	-	+
<i>Plicaria trachycarpa</i> (Curr.) Boud.	999	P1	1983	B.C.	++	+	-	++
<i>Plicaria trachycarpa</i> (Curr.) Boud.	A01746		1986	B.C.	++	++	+	+

1 Cr=p-cresol, Ty=L-tyrosine, Sy=syringaldazine, Na=l-naphthol.

2 P=polyspore isolate, M=monospore isolate, T=tissue culture isolate.

3 B.C.=British Columbia, Ont.=Ontario, Qué.=Québec, Alb.=Alberta, Canada; MN=Maine, U.S.A.

FINNISH RECORDS OF DISCOMYCETES:

GORGONICEPS VIRIDULA SP.NOV., AND ITS CULTURAL CHARACTERS

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ABSTRACT

A new species, *Gorgoniceps viridula* Huhtinen & Iturriaga, characterized by greenish apothecia and occurrence on *Pinus* cortex, is described from SW Finland. The species is relatively late in its fruiting, the peak being reached after the first frosts. The cultural characters of the new species are also described. The typification of *G. aridula* (Karst.) Karst. is clarified, and some features of the holotype illustrated.

Gorgoniceps viridula Huhtinen & Iturriaga, sp.nov.

- Figs. 1,3.

Apothecia cupuliformia vel turbinata, usque ad 0.5 mm lata, breviter stipitata, hymenium crebro convexum, clare viridum, siccum glaucum. Margo hymenium non superans, concolorosus. Exteriori parte deorsum obscure brunnea, sicca atra. Excipulum externum textura porrecta, in basi hyphae obscure brunneae, 2.7-4.5 μ m latae, crassotunicatae, in margine hyalinae vel pallide brunneae, 2.0-3.5 μ m latae, tenuiter tunicatae, cellulis terminalibus cylindratis. Asci anguste clavati, octospori, 102-136(-165) X 9.5-12.0 μ m, amyloidei, tenuiter tunicati, in apice conici, in basi uncinati. Sporae filiformes, 48-75 X 1.8-2.7 μ m, typice septemseptatae, usque ad decemseptatae, in apice rotundatae, in basi angustatae, interdum in asco gemmatae. Paraphyses cylindratae, ascos non superantes, cellulis terminalibus crebro strangulatis, 15-30 X 2-4(-4.5) μ m.

Holotype: Finland, Satakunta, Punkalaidun, Vanttila, grid 27°E 6791:282, on the underside of *Pinus sylvestris* L. cortex lying on the ground, 28.X.1985 Huhtinen 85/162 (TUR, isotypi in VEN, CUP, CBS(culture)).

Apothecia up to 0.5 mm in diameter and up to 0.3 mm high when dried, gregarious to confluent, arising from blackened areas of the substrate, not erumpent, cupulate-turbinate, disc plane to strongly convex, clearly greenish when fresh, color Küppers S10-C30-Y40 (close to "Ocean Green" in Maerz & Paul). When dried disc more bluish, Y20-M00-C50 ("Tourmaline"); yellowish and bright under UV-light. Receptacle and stipe dark brown when fresh, blackish when dried, extreme margin pale, concolorous with the hymenium, minutely fimbriate under dissecting microscope, not notably raised above the hymenium. Stipe often hidden in fresh apothecia due to the strongly convex hymenium, firm, measuring 50-90 X 150-200 μ m when dried. When dry material is mounted in either KOH or water, all hymenial elements show greenish yellow pigment, either diffuse or as prominent droplets; pigment in fresh material mainly occurring as prominent granules in juvenile asci and paraphyses; spores totally devoid of pigment.

Ectal excipulum a textura porrecta, hyphae 2.7-4.5 (-5.4) μ m broad below, with thickened, typically 0.5-0.8 μ m thick, smooth, dark brown walls, lacking gelatinous matrix; hyphae at the margin thin-walled, pale brown to hyaline, 2.0-3.5 μ m broad, terminal cells cylindrical, true hairs lacking; excipulum nonamyloid and nondextrinoid. Asci 102-136(-165) X 9.5-12.0 μ m, narrowly clavate, eight-spored, arising from croziers, apex conical, typically with a prominent protuberance at the porus, which is minutely but clearly blue in Melzer's reagent even without KOH-pretreatment, walls thin in all parts of mature asci. Spores lying parallel or rarely coiled within the ascus, 48-75 X 1.8-2.7 μ m, filiform, usually 7-septate, occasionally up to 10-septate, apically blunt, basally tapered, sometimes slightly constricted at septa, in one case only seen to be budding when still in the ascus. Paraphyses cylindrical-filiform, simple or apically once branched, septate at ca. 10-20 μ m intervals, not clearly exceeding the asci, terminal cells typically undulating-strangulated, measuring 15-30 X 2-4(-4.5) μ m.

Cultural characters: Growth slow on 2 % malt agar, even close to the optimal temperature (+22-24 °C) the radius growing only by 1.5 mm in ten days, at +17 °C by 0.9 mm and at +5 °C and 0 °C radial growth diminished to 0.2 mm in ten days. Advancing zone sharply delimited, clearly lobed, lobes traceable to the centre of culture as sharp depressions or lighter borderlines. Aerial hyphae usually restricted to the centre, densely branched, forming very prominent grey to brown tomentum with large, hyaline to amber, slimy globules, subsequently penetrated and totally covered by fungus hyphae.

Mycelial mat very dense, tough, ca. 1 mm thick, brown,

color Cailleux T70-T71 (close to "Bronze Brown" in Maerz & Paul), with a lighter brown (L90, close to "Beige") zone of varying width always present at the margin. Below the tough mycelial mat a hyaline layer of hyphae sparsely penetrating the substrate present. Two strains produce brown color (R17) to the substrate. More rarely cultures show a grey, woolly tomentum of aerial hyphae densely covering the culture. Cultures kept in total darkness as well as those kept in 12+12 hour rhythm often show one to three hyaline or dark brown, narrow bands of rhythmic growth; growth rate in these two light conditions is equal. Odor not distinctive. Extracellular oxidase negative with alcoholic gum guaiacum solution after 1, 2 and 60 minutes. Mycelium capable of moderate growth in liquid malt agar medium.

Hyphae brown, in central parts running parallel as dense bundles, individual hyphae 2-3 μm broad, sparsely branched, firm-walled (wall 0.4-0.8 μm thick), anastomosing; hyphae of the advancing zone light brown, running quite parallel, thin-walled, apical cells blunt. Aerial hyphae similar to those of the mycelial mat, but forming more pronounced mycelial strings with dense branching. Immersed hyphae below the tough mat hyaline, thin-walled, branching at 90° angles. Hyphal compartments in all parts of the culture with one clear nuclear area.

Neither the single-spore nor multispore isolates produced anamorphs or apothecia in culture on malt agar within twelve months of incubation in various temperature and light conditions.

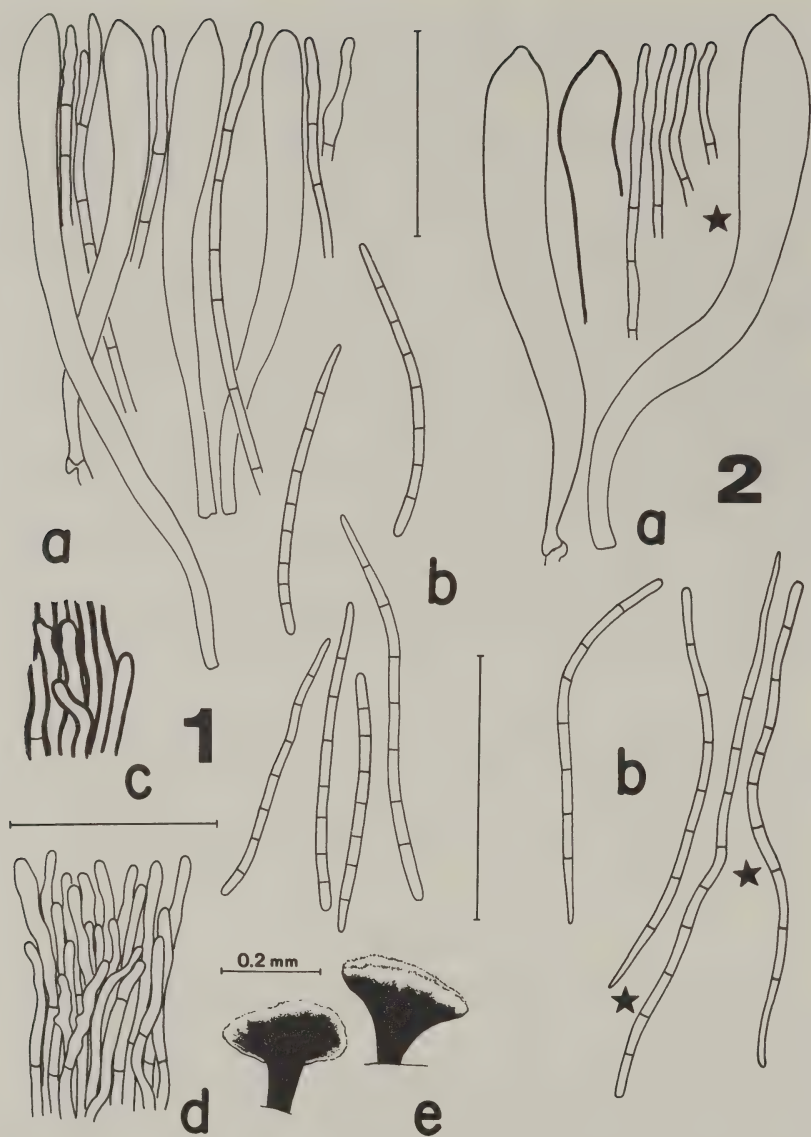
Additional collections: Finland, Varsinais-Suomi: Piikkiö, Hepojoki, grid 6715:256, 7.XI.1984 Huhtinen 84/268 (TUR); Turku, Maaria, grid 6721:243, 10.XI.1985 Huhtinen 85/170 (TUR); Maaria, grid 6725:248, 21.IX.1986 Huhtinen 86/123 (TUR); Masku, grid 6724:233, 23.IX.1986 Huhtinen 86/125 (TUR). All collections originate from fallen pieces of *Pinus* cortex.

DISCUSSION

The present new species has been collected from five separate areas in SW Finland. It seems to be truly corticolous, preferring pine as a substrate. As specimens are relatively easy to find, this is evidently a common species in the Finnish mycoflora. *Gorgoniceps viridula* is easily recognized in the field by the green color, corticolous habit and by the relatively late fruiting time; the peak being achieved after the first frosts.

The most appropriate genus for the present new taxon is *Gorgoniceps* Karst. which includes sessile to sessile, lignicolous taxa with J+ asci, filiform-multiseptate spores and an ectal excipulum comprising a textura porrecta. The distinguishing characters of this genus from *Strossmayeria* Schulzer were evaluated by Iturriaga (1984).

The present taxon is evidently very closely related to



Figs. 1-2. Type specimens of *Gorgoniceps*. 1. Holotype of *G. viridula*, in cotton blue: a) asci and paraphyses b) spores c) basal excipulum d) marginal hyphae e) dried apothecia. 2. Holotype of *G. aridula*, in cotton blue, marked in Melzer's reagent: a) asci and paraphyses b) spores. Scales 50 μm .

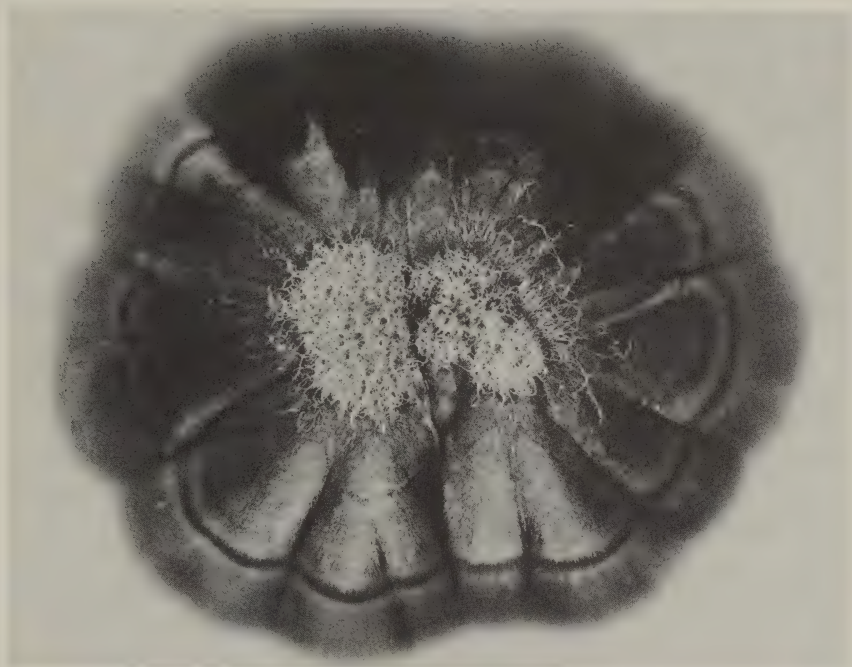


Fig. 3. *Gorgoniceps viridula*. A five-month-old pairing of two single-spore strains (Huhtinen 85/170 and 85/162) on 2 % malt agar (+17 °C, 12+12 hour rhythm), X2.7.

G. aridula (Karst.) Karst. but, from a study of collections from North America and Finland, and of the holotype of this species in H (see below), we consider that the present taxon is specifically distinct from *G. aridula*. In addition to the striking difference in apothecial pigment, there are additional differences to be found in ascus and spore size. Collections of *G. aridula* never show any green color. Furthermore, the asci in this species tend to be significantly broader, reaching 14-17 μm in the type material (Fig. 2.). The spores of *G. aridula* are longer, measuring 60-95(-108) μm in length and consequently tending to have more septa than occur in *G. viridula*.

The typification of *Gorgoniceps aridula* needs some further comments. In 1869 Karsten published *Peziza aridula* Karst. both in his "Fungi Fenniae Exsiccati" and his "Monographia Pezizarum fennicarum". As the label of F.F.Exs. 750 bears no descriptive data nor any reference to a description, the exsiccatum does not represent a valid publication of the name. Karsten's herbarium (in H) contains a collection (Messuby, autumn 1860) which was cited by Karsten (1869) and is clearly the holotype. Some features from this scanty collection are illustrated in Fig. 2.

ACKNOWLEDGMENTS

We express our appreciation to Dr. Brian Spooner for a review of the manuscript and for checking the English language.

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A SPECTACULAR LOCULOASCOMYCETE FROM VENEZUELA

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A spectacular fungus that infects branches of *Polylepis sericea* Wedd. (Rosaceae) "Coloradito" was collected on the slopes of the Cordillera de Mérida of the Venezuelan Andes, above 3,400 m. The taxon is unique in producing large, conspicuous galls, 3-14 cm in diam, weighing 1.8-335 g. Microscopic features are also unusual, in particular large dictyospores whose septa break down at maturity, followed by the formation of minute hyaline "conidia." These structures are not endoascosporic cells (Morgan-Jones, 1973), for they are much smaller and more numerous than the cells of intact ascospores. Neither ascospores nor the supposed conidia have been observed to germinate as yet, although fully mature ascomata have the centrum permeated by contorted hyphae that apparently developed from ascospores.

The collection area is a paramos region of high rainfall, limited sunshine and low temperature at tree line, with woodlands in sheltered cirques. *Polylepis sericea* occurs as scattered stunted trees or in more favorable conditions forms small forests with closed canopy. Dennis (1970), who spent two weeks in the general region, noted in a corrie woodland at Laguna Negra the presence of the trees with the endemic *Uredo polylepidis* (Arthur) Saccardo & Trotter "and bearing conspicuous galls colonised by *Flagelloscypha*

polylepidis" Reid (Cyphellaceae). This is the sole mention found in the literature to the fungus described here, despite the noticeable size of galls.

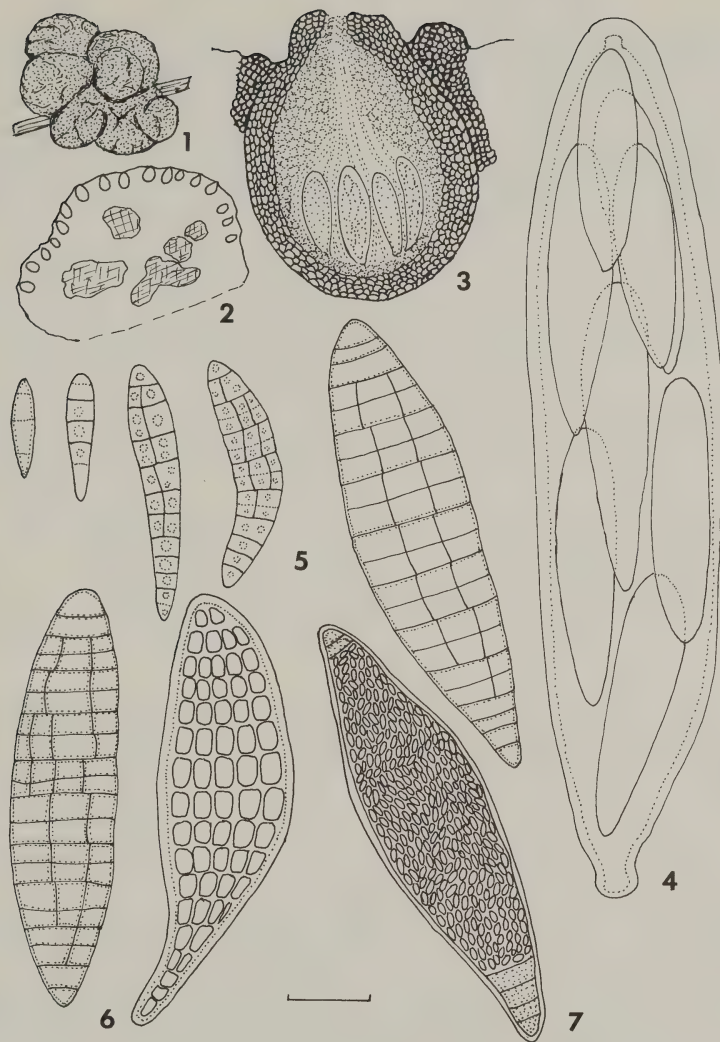
The fungus causes galls that remind one of *Apiosporina morbosa* (Schweinitz: Fr.) von Arx, on branches of *Prunus* species in temperate North America. It differs markedly from *A. morbosa* in shape of ascomata and in sizes, pigmentation, and septation of ascospores (Barr, 1963). Among dictyosporous Loculoascomycetes, *Shiraia bambusicola* P. Hennings produces tuberculate stromata up to 3.5 x 2 cm and large dictyosporous. This organism is parasitic on various bamboos in Japan and China, and the stroma is fleshy and pinkish. The ascomata are globose or sphaeroid and remain immersed in the stromatic tissues, and the peridium is narrow, composed of a single layer of cells (Amano, 1980).

The species on *Polylepis* has the characteristics of the Pleosporales ss. str.; the obpyriform ascomata and layered peridium are typical of members of the Pyrenidiaceae, in which *Teichospora* is the dictyosporous genus. Species of *Teichospora* do not form stromatic tissues or only a thin crustose layer, and do not cause conspicuous gall formation of the host plant. Other dictyosporous genera differ in other aspects, for example, some species of *Cucurbitaria* cause deformation but produce turbinate, globose, or ovoid ascomata on a basal subiculum or thin stroma. None of the dictyosporous genera now known could accommodate this species, so that a new genus must be described for it.

Grandigallia dictyospora Barr, Hanlin, Cedeño, Parra & Hernandez, gen. et sp. nov. Figs. 1-7

Stromata atra gallaeficientes 3-14 cm diametro magnorum pseudoparenchymatorum cellularum et lignorum substratorum composita; ascomata peripherae obpyriformia 440-550 μ m diametro apicibus late papillatis et ostiolis periphysatis; cellulae peridii externae pseudoparenchymatae badiae interior compressae pallidae; asci bitunicati basales 105-220 X 26-40 μ m oblongi vel ellipsoidei latis endotunicis; pseudo-paraphyses cellulosa 2-2.5 μ m latae; ascosporae hyalinae vel badiae 60-80 X 15-20 μ m fusioideae vel ellipsoideae muriformes 15-22 transverse septatae et 1-4 longitudinaliter septatae septa ad maturitas fatiscentia et contenta repleta numerosis hyalinis conidiis 2-2.5 X 0.5-1 μ m.

Parasitatur in *Polylepi sericea* Wedd., loco dicto "Paramo de la Culata, Mérida, Venezuela," supra 3,400 m, Dec 1984, a L. Cedeño, J. Parra, et R. Hernandez lecti (holotypus, MER; isotypi GAM, MASS, NY).



Figs. 1-7. *Grandigallia dictyospora*. 1. Habit of gall, X1. 2. Portion of gall in section showing position of ascomata and patches of wood cells, X ca. 10. 3. Ascoma in vertical section with part of surrounding stromatic tissue. 4. Ascus. 5. Stages in enlargement and septation of young ascospores. 6. Mature ascospores. 7. Ascospore showing numerous conidia. Standard line = 150 μ m for Fig. 3, 15 μ m for Figs. 4-7.

Causing malformations of branch as dull black, rough galls, 3-14 cm diam, firm but sectioning readily, composed of stromatic tissues formed of large thick-walled, blackish pseudoparenchymatous cells (contents bluing in Melzer's), and incorporating isolated patches of wood cells. Ascomata peripheral in stroma, bases embedded, upper regions becoming erumpent, obpyriform, 440-550 μm diam, tapered to the broadly papillate apex, cells light reddish brown, ostiolar canal periphysate; peridium externally of large dark red brown, thick-walled pseudoparenchymatous cells, internally of several rows of paler, thinner-walled, somewhat compressed cells. Asci bitunicate, basal, 105-220 X 26-40 μm , oblong or ellipsoid, endotunica wide, without apical ring, fissitunicate, cytoplasm dextrinoid, octosporous or sometimes four or less maturing. Pseudoparaphyses cellular, 2-2.5 μm wide. Ascospores hyaline for some time, becoming clear reddish brown, 60-80 X 15-20 μm , fusoid or ellipsoid, often with long taper to base; septa becoming numerous, up to 10 transverse A-septa formed before longitudinal septa, followed by B-septa, finally 15-22-septate with 1-4 longitudinal septa, at maturity septa broken down and contents replaced by numerous, small, hyaline "conidia" ca. 2-2.5 X 0.5-1 μm ; wall thick, smooth.

Parasitic on *Polylepis sericea*, Paramo de la Culata, Mérida, Venezuela, above 3,400 m, Dec 1984, collected L. Cedeño, J. Parra, and R. Hernandez (holotype, MER; isotypes GAM, MASS, NY).

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A NEW SPECIES OF CLADIA (LICHENIZED ASCOMYCOTINA)
FROM TASMANIA

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ABSTRACT: The lichen, *Cladia moniliformis*, from south-west Tasmania is described as new and the affinity of this species with *C. aggregata* and *C. inflata* is discussed. A comparative examination of *C. inflata* and *C. aggregata* has confirmed their status as distinct taxa.

Introduction

Buttongrass (*Gymnoschoenus*) moorlands in Tasmania are a major habitat of the inflated forms of *Cladia aggregata* s. lat. in Australasia. A recent botanical survey of this vegetation type (Jarman *et al.* 1987) provided the opportunity for a detailed re-examination of this morphologically and chemically variable species complex. We now report the discovery of a further, undescribed species within the *C. aggregata* complex and present arguments for the retention of *C. inflata* (F. Wilson) D. Galloway at species rank.

***Cladia moniliformis* Kantvilas & Elix, sp. nov.**

(Figure 1)

Thallus fruticosus, constans ex pseudopodetiis cavis, laxe aggregatis, fragillissimis ubi siccis, cinnamomeis vel fusciscentibus. *Pseudopodetia sterilia* decumbentia vel ascendentia, valde inflata, irregulariter bulbosa vel cylindrica, dispersim constricta praecipue ad axillas et basim, ubi bene effecta moniliformia, usque ad 80 mm longa et 12 mm lata, impolita vel nitida, laevia vel leviter rugosa, simplicia vel parce ramosa, foraminibus paucis, in magnitudine variantibus, plerumque in pagina inferiore, saepe laceratis hiantibusque. *Pseudopodetia fertilia* ascendentia vel erecta, potius gracilia, 4-50 mm alta et 2-4 mm lata, sursum gradatim decrescentia, ramosissima perforataque praecipue ad apices, plerumque pseudopodetiis sterilis inflatis exorientia, interdum discreta. *Apothecia* terminalia, lecideina, atra, nitida, 0.05-0.15 mm lata, aggregata, contigua, in stratis vulgo formata. *Sporae* hyalinae, simplices, ellipsoideae, 8-10 µm longae, 2.5-4 µm crassae. Homosekikaicum acidum et substantiae consociatae in medulla continens.

Type. Australia. Tasmania, north of Sentinel Range, ca. 4 km south-east of Mt. Cullen, on wet peaty soil in buttongrass moorland, 320m, 2.xi.1986, G. Kantvilas & J. Jarman 169/86 (HO-holotype; BM, CBG, MEL -isotypes).

Thallus fruticose, consisting of hollow, loosely clustered pseudopodetia, very fragile

when dry, mottled yellow-brown to dark brown or becoming blackened. *Sterile pseudopodetia* decumbent or ascending, very inflated, bulbous or cylindrical, irregularly constricted, particularly at the axils and at the base and forming necklace-like chains when well developed, to 80 mm long and 12 mm broad at the widest point, matt or glossy, smooth or somewhat wrinkled, particularly in older thalli, simple or sparingly branched, often with numerous short lobules; apices obtuse or tapering and ending in brown-black spines; perforations sparse, mostly on the lower surface, variable in size, often torn open and gaping. *Fertile pseudopodetia* ascending to erect, rather slender, 2-4 mm wide and 4-50 mm tall, tapering evenly, richly branched and perforated towards the apices, mostly arising from inflated, sterile pseudopodetia, occasionally discrete. *Medulla* thin, white, tomentose, becoming rough and blackened in older, torn pseudopodetia. *Apothecia* terminal on fertile pseudopodetia, lecideine, black and shiny, 0.05-0.15 mm diam., often clustered, contiguous and tiered. *Ascospores* hyaline, simple, 8/ascus, ellipsoid, $\pm$ tapered at one end, 8-10 μ m long, 2.5-4 μ m wide. *Pycnidia* narrow, cylindrical, black, superficial on sterile pseudopodetia. *Conidia* curved, 5x1 μ m.

Chemistry: homosekikaic acid (major), ramalinolic acid, sekikaic acid, unknowns (traces).

The specific epithet refers to the unique, necklace-like appearance of well developed thalli.



Figure 1. Part of isotype of *Cladia moniliformis* Kantvilas & Elix (ANUC)

Selected specimens examined (total = 44):

AUSTRALIA. Tasmania. Hermit Valley, on peat in sedgeland, 360m, 17.v.1980, *G.Kantvilas* 24/85 (herb. Kantvilas, BM); Adamsons Peak, on peat in alpine heath, 930m, 21.ix.1986, *G.Kantvilas* 161/86 (herb. Kantvilas, HO); Ten Mile Hill, Crotty Road, on peat in moorland, 430m, 15.i.1984, *G.Kantvilas* & *J.Jarman* 735/84 (herb. Kantvilas); Arthur Plains at Seven Mile Creek, on peat in moorland, 200m, 17.xii.1984, *G.Kantvilas* & *J.Jarman* 738/84 (herb. Kantvilas); Mt. Sprent, on peat in buttongrass moorland, 650m, 27.ii.1986, *G.Kantvilas* & *J.Jarman* 166/86 (herb. Kantvilas); Mt. Counsel, on peat in alpine feldmark, 750m, 12.iii.1986, *G.Kantvilas* & *J.Jarman* 164/86 (herb. Kantvilas); Mt. Agnew, on soil, 600m, 27.iii.1967, *G.C.Bratt* 4014 (HO 33234, MEL).

Distribution and Ecology

Cladia moniliformis appears to be endemic to Tasmania. It is found mostly in areas with a Precambrian geology in the wetter, western half of the island and is most common in the south-west (Figure 2). This new species grows on peat or on moist sandy or gravelly soil in buttongrass (*Gymnoschoenus sphaerocephalus*) moorlands and wet heathlands, from sea level to alpine altitudes (750-950 m). It is frequently the dominant lichen in depauperate, open graminoid heathlands where angiosperm vegetation is sparse and stunted. In very wet sites, *Cladia moniliformis* is found on low peaty mounds at the bases of shrubs and sedges. Species commonly associated with *C. moniliformis* include *Cladia inflata* (F.Wilson) D.Gall., *C. retipora* (Labill.) Nyl., *C. aggregata* (Sw.) Nyl., *C. sullivanii* (Müll. Arg.) W.Martin, *Cladonia southlandica* W.Martin, *Siphula decumbens* Nyl., *Siphula* sp., *Micarea* sp., and the bryophytes, *Campylopus introflexus* (Hedw.) Brid., *C. kirkii* Mitt., *Dicranoloma billardieri* (Brid.) Par., *D. eucamptodontoides* (Broth. & Geh.) Par. and *Goebelobryum unguiculatum* (J.D.Hook. & Taylor) Grolle. At alpine altitudes in low heathlands and bolster moors, *C. moniliformis* is associated with such lichens as *Cladia fuliginosa* R.Filson, *Cladina confusa* (R.Sant.) Follmann, *C. mitis* (Sandst.) Hustich, and *Hypogymnia lugubris* (Pers.) Krog as well as those species previously cited.

Remarks

Cladia moniliformis is closely related to *C. aggregata* and *C. inflata* but these three species can be separated by morphological differences, ecological requirements, geographic distribution and medullary chemistry (summarised in Table 1). *C. moniliformis* is the most distinctive of the three and is easily recognised by its bulbous, grotesquely inflated, sparsely branched pseudopodetia which, when well developed, are expanded and constricted and form short, bead-like chains. This unique morphology is correlated with the presence of homosekikaic acid (and associated compounds) which we have not detected in any other Australasian specimens of *Cladia*. Filson (1981) evidently did not encounter sufficient material of this species to recognise its distinctiveness although *C. moniliformis* is illustrated (as a morphological variant of *C. aggregata*) in Plate 20 (g)-(h) (Filson 1981). In some situations, particularly in alpine vegetation, *C. moniliformis* may develop to particularly lush proportions, with very elongated pseudopodetia in which the diagnostic constrictions occur mainly at the base and are readily overlooked. Such thalli are easily confused with *C. inflata*, and occasionally these two species may be intertwined. Similarly very juvenile thalli with mostly swollen, sausage-shaped lobes may also be mistaken for *C. inflata*.

Fertile specimens of *C. moniliformis* are commonly encountered but the fertile pseudopodetia occur mostly as very short, richly branched laterals of the sterile, bulbous pseudopodetia, rather than as discrete growths as in *C. aggregata* and *C. inflata*. They also tend to be relatively slender and regularly tapered, and resemble those of *C. aggregata* s. str. This is in contrast to other species of *Cladia* where fertile pseudopodetia tend to be more robust than sterile pseudopodetia. The spores of *C. moniliformis* are also consistently smaller than those of the related species.

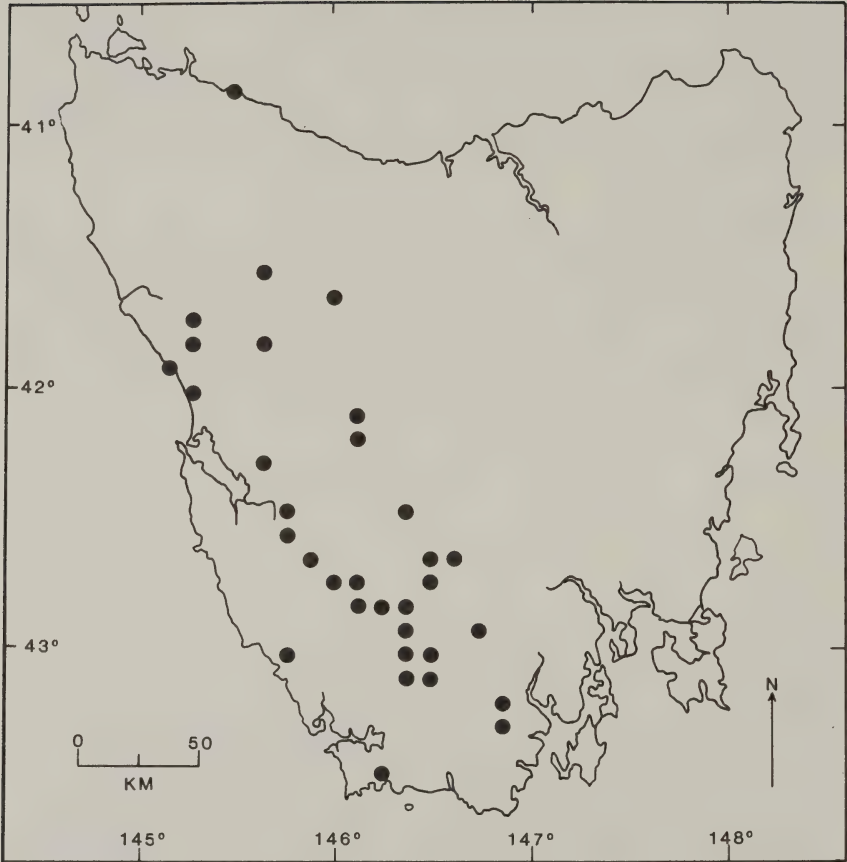


Figure 2. Distribution of *Cladia moniliformis* in Tasmania

Discussion

In the course of delimitating *C. moniliformis*, the distinctions between *C. inflata* and *C. aggregata* have been re-examined. The validity of these two taxa as separate species has proved to be a source of disagreement in recent years. Martin (1965) listed 12 varieties of *C. aggregata* s. lat. but observed that few, if any, of these formed homogeneous or disjunct groups. He also rejected any correlation between chemical and morphological strains. However, Galloway (1977) elevated *Cladonia* (i.e. *Cladia*) *aggregata* var. *inflata* F. Wilson to species rank to accommodate inflated, sparsely branched, very fragile thalli containing fumarprotocetraric acid. Filson (1981) considered *C. inflata* to be simply an inflated ecotype of *C. aggregata* but, in the most recent account of the genus, Galloway (1985) maintains these taxa as distinct species. Our own extensive field studies confirmed the latter contention (see Table 1).

C. inflata is separated from *C. aggregata* by the more inflated, more fragile pseudopodetia which are much less richly branched, and by the more acute angle of branching. Its pseudopodetia also tend to have erect apices whereas those of *C. aggregata* are often curved downwards, a feature which helps to distinguish very robust thalli of *C. aggregata* from alpine sites. The apothecial development also differs in the two species. Fertile pseudopodetia are common in Australasian specimens of *C. aggregata* and are much larger, more inflated and perforated than the sterile pseudopodetia. In contrast, fertile pseudopodetia are very rare in *C. inflata* but when present are of similar proportions to the sterile pseudopodetia, although they are generally more branched and more perforated. Furthermore the apothecia of *C. inflata* are often solitary or sparingly aggregate (1-4 apothecia per apex), separate and diminutive (0.05-0.2mm), while those of *C. aggregata* are generally densely clustered (mostly 4-10 apothecia per apex), contiguous and larger in size (0.15-0.4mm).

In general, *C. aggregata* and *C. inflata* are also chemically distinct. The vast majority of specimens of *C. inflata* contain fumarprotocetraric acid, while those of *C. aggregata* contain barbatic acid. A small minority of specimens of *C. inflata*, mostly from alpine areas of Tasmania, contain barbatic acid, but the much more varied chemistry of *C. aggregata* (e.g. the stictic acid, norstictic acid, diffractaic acid chemical races) is not observed. More important than the minor overlap in chemistry of these two species is the fact that they maintain their chemical integrity even when growing side by side. Filson (1981) maintained that there was no correlation between the extremely variable morphotypes of *C. aggregata* s. lat. and the medullary chemistry, but in our experience this is not so. In a number of sites in Tasmania where two or all three taxa co-occur, i.e. *C. aggregata*, *C. inflata* and *C. moniliformis*, the morphologically distinguishable thalli invariably maintained their unique chemistry, even when growing side by side or intertwined. Similar morphological - chemical correlations between the *C. inflata* - *C. aggregata* morphotypes also were observed in material from all sites investigated in south-eastern Australia and the South Island, New Zealand. If only one morphologically variable species were involved, it would be reasonable to expect a single chemical strain to occur in all morphotypes present at a single site. Given the consistent correlation between chemistry and morphology, we believe that *C. inflata* and *C. aggregata* are distinct species.

Intimate intertwining of thalli of the different species of *Cladia* is frequent and may lead to some confusion. For example, several collections of apparently intermediate morphology were, on closer scrutiny, separable into pseudopodetia of *C. inflata* and *C. aggregata*, with each taxon having parallel chemical differences. Furthermore, all analyses confirmed that each of the chemical races was unique (i.e. barbatic acid, fumarprotocetraric acid, homosekikaic acid, stictic acid, fatty acids, etc.) and reports of their occurrence in combination probably are due to mixed collections.

The distinctiveness of *C. aggregata* and *C. inflata* is further supported by a consideration of their ecological requirements and geographic distribution. *C. aggregata* s. str. is widely distributed in Australasia, south-east Asia, Japan, southern Africa and Madagascar, South America, Central America and the Caribbean Islands, while *C. inflata* is restricted to south-eastern Australia, Tasmania and the South Island, New

TABLE 1

Character	<i>C. aggregata</i>	<i>C. inflata</i>	<i>C. moniliformis</i>
Colour	pale green - brown-black	green-brown - brown-black	yellow-brown - brown-black
Substrate	soil, bryophytes, tree boles rocks & logs	soil, bryophytes	soil, bryophytes
Ecology	dry sclerophyll forest to wet subalpine & alpine heathland	wet lowland to subalpine & alpine heathland & grassland	wet heathland and sedgeland
Distribution	paleotropical - temperate Southern Hemisphere	SE Australia, Tasmania, South Island of New Zealand	south-west Tasmania
Pseudopodetia: Height (cm)	0.5 - 10	3.5 - 6.5	1.5 - 8.0
Width (mm)	1.0 - 3.0	2.5 - 5.0	2.0 - 12.0
Form (sterile)	erect or ascending, slender, not or slightly inflated, robust, walls thick, regularly tapered	erect or ascending, stout, inflated, fragile, walls thin, ± regularly tapered	prostrate, broad, fragile, walls thin, inflated & contracted
Branching	dense, often entangled	sparse, mainly dichotomous	sparse, often only lobules present
Angle of branches	irregular, commonly obtuse	generally acute	obtuse
Axils	± open	closed	closed, constricted
Apices	rigid, curved, horny	acute, 2- spinose, straight	obtuse, spinose when young
Perforations	round to elliptic, common	elliptic, scattered	rare, elliptic, often torn
Medulla	thin, white, rarely farinose	thin, white, tomentose	thin, white, tomentose, brown in old thalli
Form (fertile)	broad, taller, more densely perforated & branched at apices, discrete	similar dimensions to sterile pseudopodetia, but more densely branched & perforated, discrete	relatively slender, densely branched & perforated at apices, arising as laterals on sterile pseudopodetia
Apothecia	common, apical, densely aggregate, mostly 4-10 per stalk, contiguous	rare, apical, solitary or sparingly aggregate, mostly 1-4 per stalk, separate	common, apical, solitary or densely aggregate 1-10 per stalk
Disc (mm)	0.15-0.4, black	0.05-0.2, black	0.05 - 0.15, black
Spores (µm)	12 - 15 x 4 - 5 ellipsoid	10-12 x 5 tapering at one end	8-10 x 2.5-4 tapering at one end
Conidia (µm)	5 x 1, curved	5 x 1, curved	5 x 1, curved
Chemical Strains	barbatic acid (> 90%) stictic acid fumarprotocetraric acid norstictic acid diffractaic acid	fumarprotocetraric acid (> 95%) barbatic acid fatty acids	homosekikaic acid (100%)

Zealand. *C. aggregata* is tolerant of a wide range of habitats and substrates and occurs in wet and dry sclerophyll forest, cool temperate rainforest, heathlands, grasslands, montane tropical forest and alpine vegetation. Although it grows primarily on soil it can also be found over bryophytes, on logs, rocks and as an epiphyte. *C. inflata* is restricted to moist habitats in heathlands, sedgeland or grasslands where it grows over bryophytes or on peaty or inorganic soil. In Tasmania, it occurs from sea-level to alpine altitudes but in south-eastern Australia and New Zealand, it is found mostly in subalpine or alpine sites.

Despite their morphological, chemical and ecological distinctions, there is no doubt that given their morphological variability, *C. aggregata* and *C. inflata* could be considered to overlap to some extent. Intermediate or 'problem' thalli are encountered occasionally, particularly in alpine areas where both species occur and often develop very lush thalli. However, the fact that intergradation can occur between significantly different morphologies does not preclude the recognition of particular nodes within the range of variation as different taxa, especially when these nodes are further characterised by a consistent chemical difference, as in the case of *C. inflata* and *C. aggregata*. In our view, *C. inflata* represents a valid taxon within the scope of ecological, morphological and chemical variation present in the *C. aggregata* complex.

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CRITICAL PROBLEMS IN THE TAXONOMY OF PHYTOPHTHORA SPECIES IN CULTURE

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Summary

The classification of Phytophthora species has always been difficult and confusing due to the variability among and within species, inherent problems in nomenclature and absence of type cultures in many species. As yet there is still no clear means of defining species in this genus. In this review, a critical evaluation of the approaches used in Phytophthora taxonomy is presented. One of the major problems is that there are too many species to be distinguished by too few taxonomic characters which are too easily affected by cultural conditions. A comprehensive study, under standard conditions, of numerous isolates of all Phytophthora species available at the American Type Culture Collection has been initiated in order to determine the number of good species readily distinguished from one another. Each accepted species will be re-described and the type or neotype will be preserved permanently in liquid nitrogen at the ATCC to serve as reference material for the species. Information on the cultures studied will form the ATCC data base on Phytophthora and made available to the public. It is hopeful that the results of such a study not only will contribute significantly to Phytophthora taxonomy but also benefit pathological, physiological, biochemical, cytological, genetical and other studies as well.

The genus Phytophthora (Gr. phyton, a plant; phthora, destroyer) was established by de Bary (1876) with P. infestans de Bary as the type species. He recognized that the fungus causing late blight of potato in Europe in the 1840's, previously identified as Botrytis infestans Montage, later Peronospora infestans (Mont) Caspary, had unique conidiophore characteristics, which he considered distinct enough to be assigned a new genus name. By virtue of its economic importance, the biology and pathology of Phytophthora has been studied in detail and extensively reviewed (Rosenbaum, 1917; Leonian, 1925, 34; Tucker, 1931, 33; Hickman, 1958, 70; Schwinn, 1959; Rangawami, 1962; Erwin et al., 1963; Gallegly, 1970; Zentmyer and Erwin, 1970; Waterhouse, 1970; Novotel'nova, 1974; Zentmyer, 1976; Ribeiro, 1978; Erwin, Bartnicki-Garcia and Tsao, 1983; Kröber, 1985), and a sourcebook on various aspects of the genus has been compiled by Ribeiro (1978).

Despite earlier controversies over the taxonomic position of Phytophthora, it is now accepted as a genus in the family Pythiaceae of the order Peronosporales (Waterhouse, 1973). To date, over eighty different species of Phytophthora have been described. About 70 of them are plant pathogens of seed plants and their distribution is world wide (Zentmyer, 1983), resulting in more than a thousand combinations of host plant and Phytophthora, some of which have attained the status of major epidemics (Gregory, 1983). For instance, P. cinnamomi attacks 805 plant species of 273 different genera (Zentmyer, 1980), causing root and collar rot of conifers (e.g. pine, fir, cedar, juniper, cypress, yew, larch), broad-leaved trees (e.g. eucalyptus, oak, chestnut, walnut, birch, sycamore, maple), fruit trees (e.g. avocado, macadamia, pear, peach, apricot, pineapple, papaya) and ornamental shrubs (e.g. camellia, rhododendron, azalea, heather). Crandall (1950) considered it "one of the world's major plant killers". Newhook and Podger (1972) regarded Phytophthora cinnamomi in Australia and New Zealand forests as "unquestionably the most destructive pathogen ever recorded in native vegetation of this and possibly any region". P. palmivora attacks 138 plants (Chee, 1969), like cocoa, rubber, palm, citrus and pineapple, by infecting every part of the plant (Chee, 1974). It has been described by Zentmyer (1974) as "one of the most important pathogens of tropical plantation crops". According to Hickman (1958), P. parasitica occurs on members of 72 genera in 42 families of angiosperms, e.g. tobacco, tomato, cotton, citrus, cucumber and pepper; P. cactorum infects plants belonging to 83 genera in 44 families, causing damping-off of seedlings, root rot, collar and trunk canker as well as leaf and fruit rot of many valuable ornamental shrubs and fruit trees including apple, pear and peony.

Speciation within this genus has always been difficult. A fungus can be readily identified as a species of Phytophthora by aseptate hyphae with slight constriction at the base of its initially right-angled branches; by ovoid, obpyriform to limoniform sporangia produced in succession on a typically sympodially branched sporangiophore of indeterminate growth; by differentiation of mature, laterally biflagellate zoospores within the sporangium proper; by its globose oogonium with single spherical oospore and thin or no periplasm; by antheridial configuration being amphigynous and/or paragynous. But the task of naming a Phytophthora species is "not always easy" (Hickman, 1958). Indeed, Fitzpatrick (1930) once remarked that "the identification is often difficult if not actually impossible". To facilitate the definition of Phytophthora species, Blackwell (1949) standardized the terminology used while Waterhouse (1956, 1970a) compiled all original species descriptions. Detailed regional studies of Phytophthora species were conducted in many countries, for example, Argentina (Frezzi, 1950), Australia (Old, 1979), China (Ho et al. 1983a, b; 1984a, b, c, d), Greece (Kouyeas and Chitzanidis, 1968; Chitzanidis and Kouyeas, 1970), India (Rao, 1970), Iran (Ershad, 1971), Japan (Katsura, 1971), Germany (Kröber, 1975), Spain (Tuset Barrachina, 1977), Malaysia (Liu, 1977), Russia (Novotel'Nova, 1974), South Africa (Wagner, 1940), and many other tropical countries (Holliday, 1980). Lists of Phytophthora diseases of cocoa (Gregory, 1974; Gregory and Maddison, 1981) and citrus (Boccas and Laville, 1978) have been compiled. Regional keys have been introduced by Frezzi (1950) for Argentina species and by Waterhouse and Blackwell (1954) for British species. A comprehensive key was first developed by Rosenbaum (1917) who was able to differentiate 11 species based on antheridial position, shape and size of sporangia, chlamydospores and oospores. Rosenbaum emphasized biometric methods to accommodate the remarkable variability of these characters. Later, Tucker (1931) studied 150 isolations of Phytophthora representing most of the known species at that time. The diagnostic features used were mycelial growth on agar medium, growth-temperature relationships, antheridial type, sporangial dimensions, size of oospores and pathogenicity. He maintained 17 taxa as valid and identifiable species of Phytophthora. Similarly, Leonian (1925, 1934) studied all available species and varieties of Phytophthora and doubted the reliability of morphology, temperature-growth relation and pathogenicity as stable taxonomic character. Instead, he emphasized the physiological characters, for example, the ability to grow and produce sporangia, oogonia and chlamydospores at different temperatures and in the presence of different chemicals like malachite green, tartaric acid and potassium carbonate. He recognized only three good species of Phytophthora (P. cactorum, P. infestans and P. palmivora) although 22

identifiable taxa ("species") were included in his key. Waterhouse (1963) used papillation and proliferation of sporangia and the antheridial configuration as the primary taxonomic criteria in segregating 38 accepted species into six major groups which were further differentiated based on the dimensions of sporangia, antheridial form and size, oogonial diameter and ornamentations, cultural patterns, host specificity and cardinal temperatures for growth. Novotel'Nova (1974) distinguished P. gonapodyides by its saprophytism and separated the plant pathogenic taxa (21 species and 4 varieties) mainly by the ability to produce sex organs and chlamydospores, type of antheridium and shape of sporangium. In contrast to morphological measurements which were almost totally excluded, host specificity played an exceptionally important role in her key. Newhook et al. (1978) introduced a tabular "key" summarizing available information on the morphology of 43 species and 4 varieties. Similarly, Ho (1981) based on information of the morphological, physiological and pathological characteristics, compiled three separate synoptic keys to 38 species and varieties of plant-pathogenic species of Phytophthora in culture, 5 plant pathogenic species of Phytophthora known only on hosts and 9 aquatic species of Phytophthora. Recently, Gerrettson-Cornell (1985) presented a binary key for the identification of 39 species of Phytophthora which are predominantly terrestrial and can be cultured in vitro, by dividing them into eight groups based on the ability to produce sex organs, surface morphology of the oogonium, type of antheridium and sporangial formation on solid media.

Meanwhile, major advances have been made in developing new taxonomic criteria for taxa delineation (Gallegly, 1983). The chromosome number has been determined in about 16 species and varieties of Phytophthora (Brasier, 1983). The study has been hampered severely by the small size of the chromosomes (less than 1 μ). Consequently, the interpretation and the chromosome counts varied depending on the investigator. For example, working on the same isolate of P. capsici, Stephenson et al. (1974) determined the chromosome number to be 6 whereas Sansome (1976) argued that it should be 9 (8-10). Similarly, Huguenin and Boccas (1970) found 5 chromosomes in P. parasitica in contrast to 9 chromosomes as reported by Sansome (1977). In most species, about 8-12 chromosomes are found. So far, the cytological data are too incomplete to be of much value in species differentiation but the potential value of chromosome number in the taxonomy of Phytophthora is demonstrated by Brasier and Griffin (1979) when they recognized P. palmivora MF 3 (Griffin, 1977) as a distinct species: P. megakarya characterized by 5 large chromosomes in contrast to 8-12 small chromosomes in P. palmivora MF 1. Sansome and Brasier (1974) also demonstrated that P. megasperma var. sojae with small oogonia differed from P.

megasperma var. megasperma with large oogonia also in the chromosome number (10-15 vs 22-27). On the other hand, although diploid and tetraploid isolates are recognized in P. infestans and P. meadii (Waterhouse, et al. 1983), no varietal distinction is deemed necessary. Waterhouse (1974a) suggested that a study of chromosome number might be useful in determining if some of the "related species" of P. palmivora might be hybrids.

Gel electrophoresis of mycelial proteins was used by Clare and Zentmyer (1966) to differentiate P. cinnamomi, P. citrophthora and P. palmivora, by Gill and Powell (1968) to distinguish P. cactorum, P. fragariae and P. sojae and by Erselius and Shaw (1982) to differentiate P. palmivora and P. megakarya. As a result of comparative study of 42 isolates of P. cinnamomi, P. cactorum and P. palmivora (Hall et al., 1969), 30 isolates of P. cinnamomi and 5 isolates of P. cactorum (Gill and Zentmyer, 1978) it was further demonstrated that while protein patterns in electrophoresis differed markedly between species (Masago and Yoshikawa, 1983; Xu et al., 1982) they were very similar or identical within a given species, regardless of the date of isolation, host or geographic locality and mating type. It has been used, along with other conventional criteria for precise identification of P. citricola from avocado (Zentmyer et al., 1974), P. palmivora from milkweed (Freichtenberger, et al., 1984), P. drechsleri from cucumber (Ho et al., 1984b) and P. cinnamomi from Taiwan (Ann and Ko, 1985) and for establishment of new taxa as in P. pseudotsugae (Hamm and Hansen, 1983) and P. humicola (Ko and Ann, 1985). In most cases, the electrophoresis pattern correlated with the morphological characters. However, Erselius and Vallavieille (1984) pointed out that whereas the intraspecific variation of protein patterns of P. cactorum, P. capsici, P. citrophthora, P. cryptogea and P. nicotianae were negligible, no two of the four test isolates of P. citricola were identical. Hamm and Hansen (1983) also found lack of consistency in protein bands of isolates of P. cactorum. At least two distinct groups of P. megasperma could be distinguished based on protein patterns (Farris et al., 1986; Hansen and Hamm, 1986; Irwin and Dale, 1982; Matsumoto and Sato, 1985).

Isozymes were also assayed for the identification of Phytophthora isolates. Thus, Elliott and Maxwell (1984) demonstrated that the three forma speciales of P. megasperma had zymograms distinct from each other. Similarly, Old et al. (1984) found that the A1 and A2 mating types of P. cinnamomi could be distinguished isoenzymically. On the basis of the amino peptidase, Huber et al. (1982) differentiated P. palmivora, P. cinnamomi, P. drechsleri and P. cactorum.

The use of serology in Phytophthora taxonomy was first attempted by Burrell et al. (1966) using immunodiffusion and immunofluorescence tests to differentiate P. cactorum, P. cinnamomi and P. erythrosepatica. Morton and Dukes (1967) demonstrated distinct serological differences between the genera Phytophthora and Pythium but failed to detect differences between P. parasitica and P. parasitica var. nicotianae; Merz et al. (1969) compared six closely related heterothallic species of Phytophthora and found that P. arecae, P. citrophthora, P. palmivora, P. meadii and P. mexicana were serologically similar to each other but distinct from P. cinnamomi. They suggested that these five species be incorporated into one species: P. citrophthora. Halsall (1976) conducted immunodiffusion analysis of both cell wall and cytoplasmic antigens and found no difference between A1 and A2 mating types of P. cinnamomi, P. cambivora, P. cryptogea and P. drechsleri. He considered P. cryptogea and P. drechsleri as a single species -- P. cryptogea because they could not be distinguished serologically. Nearly half of the plant species attacked by P. drechsleri are also hosts for P. cryptogea (Novotel'Nova, 1974). Recently, Hardham et al. (1986) raised monoclonal antibodies to isolate-, species-, and genus-specific components on the surface of zoospores and cysts of P. cinnamomi and suggested that these specific probes could be of great value in the studies of this fungus and other Phytophthora species as well.

The ability of Phytophthora spp. to produce a brown pigment on peptone beef extract agar was first noted by Galindo and Zentmyer (1967) who used it as a genetic marker. Timmer et al. (1970) developed a casein hydrolysate tyrosine medium and showed the pigment producing ability on this medium to be widespread in the genus, with the exception of P. parasitica, P. citrophthora, P. heveae and P. phaseoli. They considered this character of little taxonomic value. On the other hand, Shepherd (1976) compared the pigment production of 138 isolates of 12 Australian species of Phytophthora and he concluded that it might be useful in preliminary screening or for confirmation. For instance, P. cinnamomi distinguished itself from the other 11 species in producing little or no pigment while A1 mating type of P. parasitica produced twice the pigment as A2 type isolates. He further suggested that since both P. drechsleri and P. cryptogea were good pigment producer they should be combined under one name -- P. cryptogea. Pigmentation in lima bean agar by P. palmivora was also a diagnostic character in distinguishing from P. meadii (Dantanarayana et al., 1984).

Microchemical analysis of cell wall is important in fungal taxonomy (Bartnicki-Garcia, 1966). The chemical composition of the cell wall of hyphae, sporangia and oospore-oogonial complex from different species of

Phytophthora are basically similar in terms of amino acids, proteins, lipids and glucan (Lippman et al., 1974; Bartnicki-Garcia and Wang, 1983). Although variations existed in the relative proportions of components, such minor quantitative differences detected so far are not significant enough to aid Phytophthora taxonomy. However, some biochemical characters, such as the structure of macromolecules, "are remarkably constant and someday might be the decisive key to settle taxonomic controversies" (Gallegly, 1983).

The nutritional requirements for growth varied considerably within the genus and under certain experimental conditions might be of value in taxonomic delineation (Hohl, 1983). For instance, Liang and Lin (1965) developed a synthetic agar medium with soluble starch as the only source of carbon. They found that different species of Phytophthora responded differently on the medium whereas isolates of the same species or variety responded similarly. Thus, P. infestans and P. boehmeriae failed to grow; P. parasitica and P. parasitica var. nicotianae showed slight growth in contrast to the luxuriant growth of P. colocasiae and P. palmivora. They suggested that starch utilization capability might be used as a diagnostic character in Phytophthora. This was confirmed by Ho and Foster (1972) who developed a simple iodine test to determine quantitatively the ability of Phytophthora spp. to hydrolyze starch on agar medium. In this way, P. palmivora and P. parasitica were readily distinguished whereas no difference was detected between P. megasperma var. megasperma and P. megasperma var. sojae. Zoberi et al. (1981) also demonstrated the synthesis of amylase in P. palmivora but not in P. megakarya. Hohl (1975) developed an artificial medium for vegetable growth. By comparing the nutritional requirements of 24 strains representing 16 species of Phytophthora in terms of nitrogen source, lecithin and other growth factors, he recognized four groups based on the level of nutritional complexity. The least demanding species like P. capsici and P. cryptogea are placed in Group I requiring only inorganic nitrogen, Group II are comprised of P. cactorum, P. cambivora, P. cinnamomi, P. citricola, P. citrophthora, P. nicotianae and P. palmivora requiring both inorganic nitrogen and lecithin; Group III needs organic nitrogen and lecithin and included P. erythrosepica, P. megasperma and P. syringae; the most demanding species require organic nitrogen, lecithin and other growth factors and are represented by P. fragariae and P. infestans in Group IV.

The use of temperature-growth relationship and pathogenicity as taxonomic character has also been re-examined. Tucker (1931) considered the temperature, especially the maximum temperature for growth to be specific. His view was not shared by Leonian (1934) but

Waterhouse (1963) used cardinal temperatures for growth in her key as well as growth rates for species differentiation. Shepherd and Pratt (1974) and Shepherd *et al.* (1974) studied the growth of 50 Australian isolates of *P. cinnamomi* and showed that growth did not occur outside the range 5-35 C. The optimal temperatures varied according to the isolate and medium used. When cultures were incubated at temperatures above which no growth occurred and then returned to 25 C, their subsequent ability to resume growth also varied considerably among isolates of *P. cinnamomi*. Similarly, Zentmyer *et al.* (1976) studied 187 isolates of *P. cinnamomi* from 24 countries and 59 hosts. The cardinal temperatures were found to be 5-16 C (minimum), 10-32 C (optimum) and 30-36 C (maximum). However, the growth-temperature response was affected by the nutrition of the agar medium.

The pathogenicity was an important taxonomic criterion in the keys of Tucker (1931) and Novotél'Nova (1974). It is now well recognized that most *Phytophthora* species have wide host range, display considerable variation in pathogenicity (Erwin, 1983) and several species may attack the same plant producing similar or identical symptoms (Chee, 1974). For instance, brown fruit rot of citrus is caused primarily by *P. citrophthora* but also by *P. palmivora*, *P. cactorum*, *P. hibernalis*, *P. parasitica* and *P. syringae*. Besides *P. palmivora*, cocoa trees are attacked by *P. megakarya*, *P. citrophthora*, *P. capsici* and *P. megasperma* (Zentmyer, 1983). *Phytophthora* spp. isolated from avocado trees include *P. cinnamomi*, *P. cactorum*, *P. palmivora* and *P. citricola* (Zentmyer *et al.*, 1974). Nevertheless, parasitism represents a unique relationship between a pathogen and its host. In general *P. infestans* is confined to members of the Solanaceae, *P. primulae* has been found only on *Polyanthus*, *P. ilicis* only on holly, *P. vignae* only on cowpeas and *P. fragariae* only on strawberries. When used with discretion along with other taxonomic criteria, the pathogenicity is still a valuable aid in preliminary screening and confirmation of unknown species of *Phytophthora*. As a matter of fact, Waterhouse (1963) differentiated *P. infestans*, *P. phaseoli*, *P. hibernalis*, *P. ilicis* and *P. colocasiae* in Group IV based solely on the host(s) on which they parasitized. Formae speciales have been used to designate isolates from specific hosts, e.g. *P. cryptogea* f. sp. *begoniae* from *Begonia-Elatior* hybrid (Kröeber, 1981), *P. drechsleri* f. sp. *cajani* from pigeon pea (Kannaiyan *et al.* 1980), *P. infestans* f. sp. *thalictri* from *Thalictrum* (Waterhouse, 1963), *P. megasperma* f. sp. *glycinea* from soybean, f. sp. *medicaginis* from alfalfa (Kuan and Erwin, 1980), f. sp. *trifolii* from Arrowleaf clover (Pratt, 1981) and *P. nicotianae* f. sp. *nicotianae* from tobacco (Erselius and Vallavierlla, 1984).

The use of chemicals and drugs like malachite green to differentiate Phytophthora spp. based on their mycelial growth responses was first introduced by Leonian (1934). With the exception of Frezzi (1950), few researchers considered this character of great taxonomic importance. Shepherd and Pratt (1973) compared the growth responses of nine Phytophthora species to copper sulfate solution and found that this method provided a substantial aid for species identification. Both "northern" and "southern" ecotypes of P. drechsleri from Australian native eucalypt forests behaved similarly in the presence of malachite green. Significant differences were found in the growth responses of A1 and A2 mating type isolates of P. cinnamomi when inhibitors like safranin O, rose bengal, pyronin G, malachite green or copper sulfate were incorporated in the medium (Shepherd et al., 1974). The inhibitory effect of malachite green on the growth of P. cryptogea and P. drechsleri was one of the criteria used by Bumbieris (1974) to demonstrate their similarity and to justify his suggestion that these two Phytophthora species should be merged under one name -- P. cryptogea. Ho (1987) demonstrated that the effect of hymexazol on the growth of low temperature Phytophthoras might be species specific. Thus, HMI severely inhibited the growth of P. infestans, P. phaseoli, P. porri and P. syringae but enhanced the growth of P. fragariae and P. ilicis slightly.

The use of morphology as a basis for taxa delineation has been questioned because morphological distinctions within the genus are too few for classification and the full range of variability of each species has not been determined (Erwin et al. 1963; Erwin, 1983). However, until other better methods are developed, the morphology is still the basis for Phytophthora taxonomy (Waterhouse, 1970; Waterhouse, et al. 1983; Kellam and Zentmyer, 1986). Waterhouse (1963) considered the sporangium and the sex organs the most important characters in Phytophthora. While differences between papillate and non-papillate sporangia are distinct as confirmed by electron microscopy (Bartnicki-Garcia and Hemmes, 1976; Hemmes, 1983) the shape and size of sporangia have been demonstrated to be variable. Gerrettson-Cornell noted (1974) that the ratio between the size of germination pore and the breadth of the sporangium was constant. Waterhouse (1974b) divided all Phytophthora spp. into two major groups with caducous and with persistent sporangia, and these were further differentiated based on the mode of sporangium shedding, the papillation of sporangium and the length of sporangial stalk. Al-Hedarth and Tsao (1977) distinguished ten species of Phytophthora based on the degree of caducity of sporangia and length of pedicels. Tsao (1977) and Trichlo and Aragaki (1982) recognized the sporangial caducity and pedicel length and ontogeny as important and stable diagnostic characters and they should be included in any

species identification. Zentmyer et al. (1977) distinguished over 300 isolates from cacao, originally designated as P. palmivora, into three or four groups based on the length of the stalk. Those isolates with short and thick sporangial stalk were placed in Group I, equivalent to MF1 of Griffin (1977), those with sporangial stalk of intermediate length in Group II, equivalent to MF3, those with long stalk in Group III while Group IV consisted of isolates with non-caducous sporangia not typical of P. palmivora. Tsao and Tummakate (1977) questioned the validity of a Phytophthora isolate from Piper, previously identified as P. palmivora because the extremely long pedicel and the umbellate arrangement of sporangia of this isolate were so distinct from the short pedicel and sympodial arrangement of typical form of P. palmivora. Tsao (1983), Alizadeh and Tsao (1983) suggested that P. palmivora MF4 isolates from black pepper and other hosts be re-named as P. capsici.

Compared with the sporangium, the morphological characteristics of the sex organs, for instance, the antheridial configuration and the size of oogonia, proved to be more stable and constant. A comprehensive study of the sexual reproduction of 350 isolates representing 30 species and varieties of Phytophthora revealed four major groups (Savage et al., 1968). Phytophthora spp. in Group I are homothallic with predominantly paragynous antheridia, like P. cactorum, P. citricola, and P. syringae, Group II as exemplified by P. boehmeriae, P. fragariae, and P. heveae are homothallic with predominantly amphigynous antheridia; Group III, the largest group, consist of species which are heterothallic with compatibility types A1 and A2 and amphigynous antheridia, e.g. P. infestans, P. cambivora, P. capsici, P. cinnamomi, P. drechsleri, P. palmivora and P. parasitica; Group IV, an optional group, includes P. erythroseptica, P. megasperma and P. sojae which are homothallic with amphigynous and paragynous antheridia in variable proportions and thus might be placed in Group I or Group II. However, the distinction between heterothallic and homothallic species is not absolute nor are the antheridial types always species specific and stable. Sex organs could be readily induced in single A2 isolates of some heterothallic species of Phytophthora in response to avocado root extract (Zentmyer, 1952, 79; Zaki et al., 1983), chloronab (Noon and Hickman, 1974), damage (Reeves and Jackson, 1974), aging (Tsao et al., 1980), Trichoderma (Brasier, 1975) and certain homothallic species (Brasier, 1972; Ko, 1980). Isolates of P. porri may be predominantly paragynous or amphigynous (Ho, 1983a) and homothallic strains of heterothallic P. cinnamomi and P. nicotianae var. parasitica were found in China (Ho et al., 1983) and United Kingdom, respectively (Sansome, 1980). Although P. megasperma is widely believed to be homothallic, producing predominantly paragynous

antheridia, 11 heterothallic isolates have been reported by Barr (1980) and they produced predominantly or entirely amphigynous antheridia in crossing (Ho, 1986). "P. erythroseptica" from arrowleaf clover produced mainly paragynous antheridia on corn meal agar but amphigynous antheridia in pea broth (Pratt, 1981). P. insolita produces no discrete antheridium at all (Ann and Ko, 1980). The nature of amphigyny and paragyny has been studied in detail by Ho (1979, 1983b, c), and amphigyny is considered the more advanced system which evolved along with heterothallism to ensure successful outbreeding (Brasier, 1983; Ho, 1983). Although most oospores formed in crossing are a result of induced selfing (Ko, 1980; Shen et al., 1983) it is still possible that intra- or inter-specific mating might occur leading to genetic recombination or some form of hybridization (Savage et al., 1968; Boccas and Zentmyer, 1976; Boccas, 1981; Shaw, 1983; Gallegly, 1983b). By pairing two compatible strains on opposite sides of a polycarbonate membrane, Ko (1978, 80, 81, 83) demonstrated the hormonal regulation of sexual reproduction in heterothallic and homothallic species of Phytophthora and based on hormone production and responsiveness to hormones, 16 possible types of sexuality divisible into three groups were recognized: cross-induction (=heterothallic) group, self-induction (=homothallic group) and neuter group. Ko (1981) and Ko et al. (1986) also discovered that the mating types of P. parasitica could be changed during long term storage or by truban and chloroneb treatments. Sansome (1985) suggested that the occurrence of homothallic isolates may be due to trisomy of the mating type locus.

The morphology of cultures on agar medium, though variable, is sometimes species specific as exemplified by the rose pattern of P. syringae and the chrysanthemum pattern of P. citricola (Waterhouse, 1970). The cultural form is in turn determined by the frequency, angle and extent of branching of the hyphae which are often stable characters (Chesters, 1968). Indeed, Galindo and Zentmyer (1967) used thread branching and arbuscular branching as genetic markers in P. drechsleri. Bumbieris (1974) compared the width of hyphae of P. drechsleri and P. cryptogea to demonstrate their similarity. Ho (1978) analyzed quantitatively the hyphal branching systems at the periphery of fungal colonies of P. cactorum, P. cinnamomi, P. megasperma and other Phycomycetes, using parameters like length of apical segment, length ratio, hyphal density and hyphal growth unit. It was found that the characteristics of a hyphal branching system might be useful in taxa delineation.

With the advent of electron microscopy, major advances have been made in the study of morphology and structure in this genus. So far, the fine structure of about eight species of Phytophthora has been elucidated. In general,

Phytophthora spp. are similar at the ultrastructural level although minor variations exist in detail (Bartnicki-Garcia and Hemmes, 1976; Hemmes, 1983; Ho, 1979a). For instance, the oogonial wall of P. palmivora (Vujčić, 1971), P. megasperma var. sojae (Hemmes and Ribeiro, 1977) and P. macrospora (Fukutomi et al., 1971) is made up of only one dense layer whereas P. capsici has several irregularly spaced confluent layers (Hemmes and Bartnicki-Garcia, 1975). The sporangial wall consists of two layers in P. erythroseptica (Chapman and Vujčić, 1965), P. macrospora (Akai et al., 1976), P. parasitica (Hohl and Hamamota, 1967) and P. palmivora (Gisi et al., 1979), with the outer layer wall continuous over the apex and confluent with the apical papilla material. In P. infestans (King et al., 1968), there is only one layer in the sporangial wall, with the apical pore blocked by a laminated papilla. The scanning electron microscope also gives excellent resolution of the gross or surface morphology of biological materials. The technique was used by Desjardins et al. (1973) to confirm the morphology of zoospores of P. palmivora, by Ho and Zentmyer (1977) in the study of morphology of P. cinnamomi and by Ho et al. (1977) in demonstrating the bullate papillae of P. cambivora. By a combination of transmission and scanning electron microscopy, Ho (1979a, b; 1983a, b) studied the nature of paragyny and amphigyny and demonstrated that while the oogonial wall of P. cactorum, P. citricola, P. heveae and P. palmivora is smooth, it is finely granular in P. megasperma and P. megasperma var. sojae and coarsely granular in P. parasitica.

In spite of new developments, species identification in Phytophthora still often proves to be a frustrating experience. To a large extent, this is attributable to the incompleteness, overlapping and inaccuracy of many original descriptions and the absence of type materials for more than half of the species described so far. Although the type strain may not be typical of the species (Erwin, 1983; Brasier, 1983) it is indissolubly tied to the nomenclature as governed by International Code of Botanical Nomenclature and the type or neotype culture should be used as the starting point or base for speciation (Waterhouse, 1970). For instance, the taxonomy of P. palmivora has always been confusing because the original description by Butler (1907) was far from being definitive and no type culture was available for comparison. Consequently, many isolates, especially those from cocoa and rubber trees in tropical countries, producing papillate sporangia, chlamydospores and amphigynous antheridia in pairing, have been identified as P. palmivora which was thus described as extremely variable (Leonian, 1934; Zentmyer, 1974), so much so that four morphological forms were recognized (Griffin, 1977). While most Phytophthora researchers agreed that MFL

represented the valid P. palmivora species, MF3 was proved to be distinct enough to warrant a new species epithet: megakarya (Brasier and Griffin, 1979) and MF4 was redesignated as P. capsici (Tsao, 1983; Alizadeh and Tsao, 1985). The resemblance in the sporangial characteristics of MF4 and P. capsici was not realized until isolates of the former were compared with the type culture of the latter (Kaosiri et al., 1978), because deciduous, long-pedicellate sporangia were not mentioned in the original description by Leonian (1922). Babacauh (1983) erected a new variety, P. palmivora var. heterocystica to accommodate the atypical forms of P. palmivora from cocoa in Ivory Coast. The perennial controversy over P. nicotianae and P. parasitica (Erwin, 1983), is at least partially due to the incompleteness and overlapping of original descriptions by Breda de Haan (1896) and Dastur (1913) and the absence of type cultures for comparison.

The importance of original descriptions and the need for comparison with the type culture are highlighted in the identification of a species of Phytophthora causing blight of cucurbits in the Far East. It was identified by Katsura (1968) in Japan as a new species: P. melonis, because it was distinct from P. capsici and P. parasitica and characterized by semi-papillate sporangia. Consequently, P. melonis has been placed in Group IV of Waterhouse (Newhook et al., 1978) and many isolates of Phytophthora from cucurbits in China were designated as P. melonis (Wong and Jiang, 1980; Lu and Gong, 1982). Yu and Zhuang (1982) studied some of these isolates and found non-papillate, internally proliferating sporangia. Based on published data only, they considered the isolates distinct enough to be treated as a new species: P. sinensis. By comparing a variety of isolates from Cucumis species in China with P. drechsleri, P. sinensis and the type culture of P. melonis under standard culture conditions, Ho et al. (1984b) demonstrated their striking similarity, especially in the production of non-papillate, internally proliferating sporangia of similar shape and size, and concluded that they should all be referred to as P. drechsleri. Ho (1986) further discovered that these isolates are also similar to the isolate of P. drechsleri from cucumber in Iran (Ershad and Mostowfipoor, 1969) and the isolates of "P. melonis", from cucurbits in Taiwan and Japan, and suggested P. melonis and P. sinensis be synonymous with P. drechsleri.

The need for comparative study under uniform conditions in the classification of Phytophthora was recognized as early as 1917 by Rosenbaum when he prepared the first key to this genus: "There was a great need of a comparative study under the same conditions of all the described species of the genus. Hitherto, the various species have never been gathered and grown by any one investigator; nor had comparison been made when grown under similar

conditions; nor had any general survey of the genus been made since it was established...." Unfortunately, some 60 years later, we are in no better position. Thus, Waterhouse et al. (1983) urged that "species should be redescribed from material grown under standard growing conditions, with establishment of new types where originals are not available. Only then will many of the difficulties inherent in the present situation be resolved".

One of the major problems in Phytophthora taxonomy is that there are too many species to be distinguished by too few taxonomic characters which are too easily affected by cultural conditions. For too long, researchers have been looking for minute details to differentiate species so that the present taxonomic keys are "too finely tuned" (Gallegly, 1983), comprising too many "narrow, delimited categories ... recognized as species or varieties" (Erwin, 1965). Numerous isolates (including the type and/or authentic) of all Phytophthora species must be re-examined under standard conditions to determine the number of "good" species based on overall similarity (Snyder and Hansen, 1954; Ho, 1981, 82). Although we do not subscribe to Leonian's notion (1934) that there are only three good species of Phytophthora, Ribeiro's estimate (1978) of "only a dozen or so valid species" does not appear to be such a "radical view" either.

The large collection of Phytophthora cultures (approximately 500) at the ATCC, representing isolates of nearly all species known to date, from all over the world, serve as an excellent resource for such a comprehensive study. We have already completed a comparative study of 19 isolates of P. cryptogea and 14 isolates of P. drechsleri and found that they could not be separated into two distinct species (Ho and Jong 1986). Our study is being expanded to include other species as well. Once the number of "good" species is determined, each species will be re-described and the type or neo-type will be preserved permanently in liquid nitrogen at the ATCC to serve as valuable reference material for the species. Information on these reference cultures and other cultures studied will be stored in the ATCC computer system and made available for others to use. It is hopeful that a revision of the genus Phytophthora will provide a useful basis for pathological, physiological, biochemical, cytological, genetical and other studies.

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CANOMACULINA, MYELOCHROA, PARMELINELLA,
PARMELINOPSIS AND PARMOTREMOPSIS, FIVE NEW GENERA IN
THE PARMELIACEAE (LICHENIZED ASCOMYCOTINA)

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ABSTRACT : The genera *Canomaculina* Elix & Hale gen. nov., *Myelochroa* (Asahina) Elix & Hale stat. nov., *Parmelinella* Elix & Hale gen. nov., *Parmelinopsis* Elix & Hale gen. nov. and *Parmotremopsis* Elix & Hale gen. nov. are here segregated from *Parmelina* s.str. The main differences between the genera lie in the chemical properties of the medulla, the centres of distribution, the habitat requirements, the nature and distribution of the cilia, the lobe and rhizine morphology and the size of the spores and conidia.

Introduction

The lichen genus *Parmelina* Hale was erected in 1974 (Hale 1974) to accommodate those narrow-lobed, marginally ciliate *Parmeliaceae* previously assigned to *Parmelia* subgenus *Parmelia* section *Imbricaria* (Schreber) E.Fries (Hale & Kurokawa 1964). The genus so defined could not only be recognized by the presence of narrow, adnate lobes and marginal cilia, but also by the simple to sparsely furcate or squarrosely branched rhizines, the adnate to sessile apothecia with imperforate discs and the upper cortex consisting of palisade plectenchyma with a pored epicortex (Hale 1976).

At that time it was recognized (Hale 1976) that *Parmelina* so defined comprised several heterogenous elements differing in lobe width, the production of cilia, medullary pigmentation, and rhizine branching. Two major groups of species were recognised: one where the species contained the medullary triterpenes and the other lacking these substances. These taxa were given the status of sections, namely *Parmelina* section *Parmelina* Hale with *Parmelia tiliacea* (Hoffmann) Hale as type species (lacking triterpenes); and *Parmelina* section *Myelochroa* (Asahina) Hale with *Parmelina aurulenta* (Tuck.) Hale as type species (containing triterpenes).

There have been a number of recent studies on generic segregates of the *Parmeliaceae*, leading to further development and refinement of the generic concepts in this large family (Elix, Johnston & Verdon 1986; Goward 1985; Hale 1981, 1986a, 1986b; Krog 1982a, 1982b). Characters such as spore size, type of conidia, rhizines and cilia, secondary product chemistry and phytogeographic patterns have been re-evaluated and shown to be consistent and highly correlated. With this background it is now possible to identify and segregate homogeneous entities from *Parmelina* sens. lat.

at the generic level.

Thus *Parmelina* sens.str. only includes a relatively small group of eight species related to *Parmelina tiliacea*, the type of the genus. All but one species [*P. endoleuca* (Taylor) Hale with traces of fatty acids] contain medullary lecanoric acid, while the upper cortex contains atranorin and chloroatranorin. As now conceived this genus is further characterised by small to medium sized spores (5-8 x 8-14 µm), medium sized (4-7 µm) cylindrical to weakly fusiform conidia, and relatively sparse simple marginal cilia which are concentrated in the lobe axils. The lower surface is uniformly black and the rhizines simple. The upper surface is strongly white spotted-maculate in four species (*P. carporrhizans*, *P. pastillifera*, *P. quercina*, *P. tiliacea*) and weakly so in several others (*P. conlabrosa*, *P. labrosa*, *P. stevensiana*). By and large *Parmelina* appears to be an Old World genus with centres of speciation in Euroasia and Australasia.

This combination of characters clearly distinguishes *Parmelina* sens.str. from the remaining species previously included in this genus (Hale 1974, 1976). Currently we consider *Parmelina* to comprise the following species: *P. endoleuca*, *P. carporrhizans*, *P. conlabrosa*, *P. labrosa*, *P. pastillifera*, *P. quercina*, *P. stevensiana* and *P. tiliacea*.

Given this new, more restrictive circumscription of the genus *Parmelina*, we now segregate *Parmelina* section *Myelochroa* at the generic level (*Myelochroa*) as well as the *P. wallichiana* group (*Parmelinella*), *P. horrescens* group (*Parmelinopsis*), the *P. pilosa* group (*Canomaculina*) and the *P. antillensis* - *P. phlyctina* pair (*Parmotremopsis*). These segregates differ from *Parmelina* sens.str. by a combination of morphological, distributional, ecological and chemical characters which we have summarized in the key and in Tables 1 and 2 as discussed below.

Key to the segregate genera of *Parmelina* sens.lat.

Thallus with narrow, adnate lobes, marginal cilia and cortical atranorin and chloroatranorin.

1. Cilia robust, markedly tapered, commonly furcate; upper surface with effigurate maculae; conidia filiform (12-16 µm).....*Canomaculina*
1. Cilia slender, not markedly tapered, simple; upper surface emaculate or with spotted maculae; conidia cylindrical or bifusiform (3-8 µm).....2
2. Medulla yellow at least in part, containing secalonic acids.....*Myelochroa*
2. Medulla white, lacking or rarely traces of secalonic acids.....3
3. Cilia evenly dispersed, apices of lobes truncate; rhizines furcate to weakly dichotomously divided; conidia small (3-5 µm).....*Parmelinopsis*
3. Cilia mainly in lobe axils, apices rotund; rhizines simple, conidia usually larger (4-8 µm).....4
4. Lobes narrow (1-6mm), medulla containing lecanoric acid or fatty acids.....*Parmelina*
4. Lobes broad (5-10mm), medulla containing norstictic or salazinic acids.....5
5. Spores large, 8-10 x 15-18 µm; containing salazinic acid.....*Parmelinella*
5. Spores small, 3-6 x 7-8 µm; containing norstictic acid.....*Parmotremopsis*

Morphology

The Spores and Conidia

While the overall morphology of the apothecia and spores are relatively uniform throughout the Parmeliaceae, the size of the spores is quite variable. For example, *Parmotrema* and *Flavoparmelia* consistently possess larger spores (greater than 14 μm long) than do *Xanthoparmelia* and *Relicina* (less than 12 μm long). In the present complex, *Canomaculina* (8-12 x 12-20 μm), *Parmelinella* (8-10 x 15-18 μm) and *Parmelinopsis* (8-12 x 12-18 μm) have significantly larger ellipsoid spores than do *Myelochroa* (5-10 x 8-15 μm) and *Parmelina* sens.str. (5-7 x 8-12 μm) while in *Parmotremopsis* the spores are still smaller and subspherical (4-6 x 6-8 μm).

In several recent circumscriptions of parmelioid genera considerable importance has been attributed to variations in the shape and size of the conidia (Elix, Johnston & Verdon 1986; Krog 1982a). For example, *Punctelia* is the only parmelioid genus to have species with unciform conidia while the related genus *Flavopunctelia* has bifusiform conidia (Krog 1982b; Hale 1984). Similarly *Pseudoparmelia* sens.str. has elongated bifusiform or filiform conidia (12-20 μm) while related *Paraparmelia* has short (5-7 μm) bifusiform conidia.

The conidia of *Parmelina* sens.str. are medium sized (4-7 μm) and cylindrical to weakly fusiform in shape, while the conidia of *Canomaculina* are long (12-16 μm) and filiform, those of *Myelochroa* medium sized (5-7 μm) and bifusiform or cylindrical, those of *Parmelinella* medium sized (5-9 μm) and cylindrical while those of *Parmelinopsis* and *Parmotremopsis* are consistently small (3-5 μm) and cylindrical.

Thalline Characters

There are major morphological distinctions between the segregates of *Parmelina* sens.lat. The characters are consistent amongst the members of a particular segregate.

One particularly prominent and distinctive feature is the nature and distribution of the marginal cilia. In particular, *Canomaculina* is distinguished by the dense, short, robust, evenly distributed, characteristically tapering cilia. The remaining genera all have slender, barely (or not) tapering cilia. The cilia are relatively dense and evenly distributed in *Parmelinopsis*, while they are sparse and more or less restricted to the axils of the lobes in *Parmelina* sens.str., *Parmelinella* and *Parmotremopsis*. Only in *Myelochroa* do the cilia vary from being relatively dense to sparse and restricted to the axils of the lobes.

The nature of the rhizines is another such feature. Simple rhizines are characteristic of *Parmelina* sens.str., *Parmelinella* and *Parmotremopsis* while a combination of simple and squarrosely branched rhizines is typical of *Myelochroa*. *Parmelinopsis* and *Canomaculina* on the other hand invariably have a combination of simple and sparsely furcate (weakly dichotomously branched) rhizines.

One characteristic feature of the genus *Canomaculina* is the presence of distinct, effigurate maculae on the upper surface of the lobes. These maculae are submacroscopic pale spots or areas resulting from discontinuities in the layer immediately below the upper cortex. Such maculae are not observed in the other segregate genera except some species of *Parmelina* sens.str. (*P. carporrhizans*, *P. pastillifera*, *P. quercina* and *P. tiliacea*). However species of the latter genus are clearly distinguished from *Canomaculina* by other morphological features (see Table 1), particularly by the short, weakly fusiform or cylindrical conidia.

The configuration of the lobes is also quite distinctive in *Parmelinopsis* and *Parmotremopsis*. The species of *Parmelinopsis* have lobes which are typically sublinear-elongate, dichotomously divided and truncate at the apices while in *Parmotremopsis* the lobes are broad, apically rotund and with simple marginal cilia. Although the lobe configuration is more variable in *Parmelina* sens.str., most species have relatively narrow (1-3 mm wide), irregular lobes with subrotund apices. Broader irregular lobes (1.5-6.0 mm wide) with rotund to subrotund apices are typical of *Canomaculina*, *Parmelinella* and *Myelochroa*.

Table 1
SEGREGATES OF PARMELINA

Group	<i>Parmelina</i>	<i>Canomaculina</i>	<i>Myclochoa</i>	<i>Parmelinella</i>	<i>Parmelinopsis</i>	<i>Parmotremopsis</i>
Medulla (colour)	white	white	yellow-orange	white	white	white
Substrate	corticolous rarely saxicolous	corticolous rarely saxicolous	corticolous rarely saxicolous	corticolous & saxicolous	corticolous rarely saxicolous	corticolous
Habitat	cool temperate and temperate areas	savannah woodland & montane forests	warm temperate and tropical montane forests	open subtropical & tropical woodland	warm temperate & tropical montane forests	tropical montane rainforests
Distribution	Euroasia, Australasia North America	South America, Africa, Australia (1sp.)	Eastern Asia & North America	Southern Asia, Africa, Australia (1sp.)	Pantemperate & pan-tropical	Caribbean & Central America
Spores μm	5-7 x 8-12	8-12 x 12-20	5-10 x 8-15	8-10 x 15-18	8-12 x 12-18	4-6 x 6-8
Conidia μm	cylindrical-subfusiform 4-7	filiform 11-16	cylindrical-bifusiform 5-7	cylindrical 5-9	cylindrical-bifusiform 3-5	cylindrical 3-5
Lobes	narrow (1-6mm) apically subrotund	moderate (2-6mm) apically rotund	moderate (2-4mm) apically rotund	broad (4-10mm) apically rotund	narrow (0.5-2mm) apically truncate	broad (5-10mm) apically rotund
Cilia	sparse, in lobe axils simple, slender	dense, even, furcate, tapered	sparse to dense simple, slender	sparse, in lobe axils simple, slender	dense, even simple, slender	sparse, in axils simple, slender
Upper surface	$\pm$ spotted maculae	effigurate maculae	emaculate or simple maculae	emaculate	emaculate	emaculate $\pm$ flaking
Lower surface	black	black	black	black	black to brown-black	black
Rhizines	simple	simple - furcate	simple - squarrose	simple	simple - dichotomous	simple
Vegetative propagules	25% soredia/pustules 25% isidia	60% soredia/pustules no isidia	35% soredia/pustules 20% isidia/oboles	33% isidia	30% soredia/pustules 40% isidia/oboles	50% isidia

Distribution and Ecology

All five segregate genera have well defined centres of distribution and habitat requirements. *Parmelina* sens. str. occurs primarily in Europe and Australasia with *P. carporrhizans* a disjunct in western North America. It is confined to corticolous substrates. *Myelochroa* is mostly corticolous in temperate forests with the greatest number of species in eastern Asia (particularly Japan) and secondarily in eastern North America. One species, *M. aurulenta*, is pantemperate.

Canomaculina is both corticolous and saxicolous in the drier, tropical and subtropical savannah woodland areas of Central America, South America and more rarely southern Africa and Australia. *Parmelinella* has similar habitat requirements to *Canomaculina*, but the centre of distribution of this genus is southern Asia, particularly India. The most widespread species is *P. wallichiana*, which extends from east Africa to Asia and Australia. *Parmotremopsis* is always corticolous, with a restricted distribution in montane tropical forests of the Caribbean and Central America.

Parmelinopsis is the most widespread segregate with significant numbers of species in the Americas, Australia and southern Africa, as well as three pantemperate species, *P. horrescens*, *P. minarum* and *P. spumosa*. Most of the species occur in moist temperate, subtropical and montane tropical woodlands.

Chemistry

The upper cortex of all species of *Parmelina* sens. lat. invariably contain atranorin and chloroatranorin and lack usnic acid.

The main classes of medullary substances encountered in the species of *Canomaculina*, *Myelochroa*, *Parmelina* sens. str., *Parmelinopsis* and *Parmotremopsis* are detailed in Table 2. Although there is some overlap in medullary chemistry of some segregates, definite trends are obvious. Each of the genera exhibit significant chemical differences from one another, but considerable uniformity within each genus.

Myelochroa is characterised by the presence of the yellow-orange medullary pigments, secalonic acid A (entothein) and related compounds. These pigments are not always distributed evenly throughout the medulla of these species; in *M. galbina* for instance the pigment is concentrated below the apothecia. The species of *Myelochroa* (apart from *M. immiscens* and *M. lindmanii*) also contain significant quantities of the hopane triterpenes zeorin, leucotylin, leucotylic acid and related compounds and these two chemical features clearly distinguish them from the other segregate genera (and indeed from virtually all other Parmeliaceae). A subgroup within the genus also contain the β -orcinol depsidones, galbinic acid and salazinic acid (traces) in addition to the above compounds. Traces of the secalonic acid derivatives also occur in the cortex of *Parmelinella*, but the medulla is not pigmented in this genus and terpenes are either absent or present in only trace quantities.

The orcinol depside, lecanoric acid, occurs in all species of *Parmelina* sens. str. except *P. endoleuca* which contains the aliphatic acid, protolichesterinic acid. A similar combination of medullary chemistries (i.e. lecanoric acid or fatty acids) is observed in other genera in the Parmeliaceae, for instance *Punctelia* and *Flavopunctelia*. In *Parmelinopsis* the orcinol tridepsides of the gyrophoric acid - hiascic acid chemosyndrome are preponderant and occur in various combinations in all but four species. The latter species (*P. jamesii*, *P. pindarensis*, *P. radiculata*, *P. swinscowii*) contain medullary β -orcinol depsidones, protocetraric acid, stictic acid or salazinic acid.

The β -orcinol depsidones (salazinic acid, virensic acid and stictic acid) also occur in *Canomaculina* but here two species (*C. pilosa* and *C. consors*) contain only traces of fatty acids in the medulla. Both species of *Parmotremopsis* contain the β -orcinol depsidones, norstictic acid and connorstictic acid and all three species of *Parmelinella* contain salazinic acid and consalazinic acid.

Generic Interrelationships

Myelochroa, *Parmelinella* and *Parmelina* sens. str. are unique among the genera of the Parmeliaceae. In some respects *Canomaculina* resembles the genus *Parmotrema* and indeed Krog and Swinscow (Krog & Swinscow 1981, 1983) considered *C. pilosa* and *C. consors* to belong to that genus. Thus the marginal cilia and filiform conidia present in *Canomaculina* are also observed in many *Parmotrema* species. *Canomaculina* is

Table 2

CHEMISTRY OF SEGREGATES OF PARMELINA

Group	<i>Parmelina</i>	<i>Canomaculina</i>	<i>Myelochroa</i>	<i>Parmelinella</i>	<i>Parmelinopsis</i>	<i>Parmotrempsia</i>
Chemistry (Medullary)						
Secalonic acids	absent	absent	present	± traces	absent	absent
Lecanoric acid	common	absent	absent	absent	± traces	absent
Orcinol tridepsides	absent	absent	absent	absent	common	absent
β-Orcinol depsidones	absent	common	common	present	uncommon	present
Fatty acids	uncommon	common	absent	absent	uncommon	common
Triterpenes	absent	absent	common	± traces	absent	absent
Chemistry (Cortical)						
Secalonic acids	absent	absent	present	common	absent	absent
Atranorin & chloroatranorin	present	present	present	present	present	present

distinguished by the short, markedly tapered cilia, the generally narrower lobes (2-6 mm), the effigurate maculae on the upper surface and the presence of furcate as well as simple rhizines. *Parmotrema*, on the other hand generally has much broader lobes (5-10 mm), slender, elongate cilia, simple rhizines and an upper surface with simple or no maculae. The cilia of *Canomaculina* are more reminiscent of weakly inflated bulbate cilia observed in the genus *Bulbothrix*. However *Canomaculina* is clearly distinguished from the latter genus by the large spores (8-12 x 12-20 μm) and filiform conidia while *Bulbothrix* has smaller spores (5-12 μm) and bifusiform conidia.

As the *Parmelinopsis* species have lobes which are typically sublinear-elongate, dichotomously divided and truncate at the apices, they appear superficially similar genus *Hypotrachyna* (Krog & Swinscow 1979). However, *Hypotrachyna* is distinguished by the larger, more rigid thalli and generally broader lobes, the presence of more or less richly dichotomously branched rhizines and the absence of marginal cilia. Furthermore the conidia of *Hypotrachyna* are bifusiform while those of *Parmelinopsis* are generally cylindrical.

In *Parmotremopsis* the broad, apically rotund lobes, with simple marginal cilia are reminiscent of the genus *Parmotrema*. However, species of *Parmotrema* are readily distinguished by the presence of much larger spores (12-40 μm long) and the elongate-filiform (10-20 μm), sublageniform conidia (5-8 μm) or large cylindrical conidia (5-9 μm long). In contrast *Parmotremopsis* has small spores (6-8 μm long) and cylindrical conidia (3-5 μm long).

Discussion

The main morphological, chemical, ecological and distributional traits of the species in *Parmelina* sens. str., *Canomaculina*, *Myelochroa*, *Parmelinopsis* and *Parmotremopsis* are outlined in Tables 1 and 2. They indicate that these segregates differ in a number of taxonomically important characters including spore size, conidial size and morphology, medullary chemistry, centres of distribution, lobe configuration and the nature of the rhizines as well as several minor characters. Since relative uniformity can be demonstrated within each of the segregate groups, it provides support for the proposed generic splits.

Canomaculina Elix & Hale gen. nov.

Thallus foliaceus, lobis subirregularibus, pagina superiore cinerea, effigurato-maculata, atranorinum et chloroatranorinum continens; margine ciliatis, ciliis brevibus, furcatis, robustis, contractis; pagina inferior nigra vel brunnescens, rhizinis simplicibus vel furcatis instructa. Apothecia laminalia, substipitata, disco integro vel raro perforato, sporis octonis, ellipsoideis, 8-12 x 12-20 μm . Pycnidia laminalia, conidiis filiformibus.

Typus generis: *Parmelia pilosa* Stizenberger, Ber. Tatig. St. Gall. Naturwiss. Gesell., 1888-1889, 165. 1890. [*Canomaculina pilosa* (Stizenberger) Elix & Hale]

Thallus foliose, lobes subirregular, subrotund at the apices (1.0) 2.0-4.0 (-5.0) mm broad, densely ciliate, *cilia* short, robust, markedly tapered, commonly furcate. *Upper surface* uniformly grey, conspicuously effigurate - maculate, commonly pruinose towards the apices, with a perforate polysaccharide covering. *Medulla* white. *Underside* black or rarely brown, rhizinate, rhizines simple and sparsely furcate-branched, with a mixture of coarse and fine rhizines. *Apothecia* laminal, disc usually entire but occasionally perforate, spores ellipsoid, simple, 8 per ascus, 8-12 x 12-20 μm . Pycnidia laminal, conidia filiform, 12-16 μm . The upper cortex containing atranorin and chloroatranorin.

This new genus is considered to include the following species:

Canomaculina consors (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia consors* Nyl., Flora, Jena 68, 613. 1885

***Canomaculina muelleri* (Vain.) Elix & Hale, comb. nov.**

Basionym: *Parmelia muelleri* Vain., Acta Soc. Fauna Flora Fennica, **7**, 49. 1890

***Canomaculina pilosa* (Stiz.) Elix & Hale, comb. nov.**

Basionym: *Parmelia pilosa* Stiz., Ber. Tatig. St. Gall. Naturwiss. Gesell.,
1888-1889, 165. 1890

***Myelochroa* (Asahina) Elix & Hale, stat. nov.**

Basionym: *Parmelia* sect. *Hypotrachyna* subsect. *Myelochroa* Asahina,
Lichens of Japan, II: Genus *Parmelia*, **74**. 1952

Synonym: *Parmelina* sect. *Myelochroa* (Asahina) Hale, Smithsonian Contrib. Bot. **33**,
15, 1976

Type species: *Parmelia aurulenta* Tuck., Am. J. Science & Arts, ser. 2, **25**, 424.
1858. [*Myelochroa aurulenta* (Tuck.) Elix & Hale]

Thallus foliose, corticolous or less commonly saxicolous, adnate to loosely adnate, lobes sublinear to subirregular, apically subrotund, margins ciliate, *cilia* sparse to dense, confined to the axils of the lobes or evenly dispersed, simple, slender. *Upper surface* grey, occasionally with a yellow tinge, emaculate or with simple maculae, with a perforate polysaccharide covering. *Medulla* yellow - orange at least in part due to the presence of secalonic acid A and/or related compounds. *Lower surface* black, moderately to densely rhizinate, rhizines simple or sparsely furcate and squarrosely branched. *Apothecia* adnate to substipitate, imperforate, spores ellipsoid, simple, 8 per ascus, 5-8 x 8-14 μm . *Pycnidia* laminal, conidia cylindrical or bifusiform, 4-7 μm long. The upper cortex fragile, containing atranorin, chloroatranorin and secalonic acids.

This new genus is considered to include the following species:

***Myelochroa amagiensis* (Asahina) Elix & Hale, comb. nov.**

Basionym: *Parmelia amagiensis* Asahina, J.Jap. Bot., **26**, 228. 1951

***Myelochroa aurulenta* (Tuck.) Elix & Hale, comb. nov.**

Basionym: *Parmelia aurulenta* Tuck., Am. J. Science & Arts, ser. 2, **25**, 424. 1858

***Myelochroa crassata* (Hale) Elix & Hale, comb. nov.**

Basionym: *Parmelina crassata* Hale, Smithsonian Contrib. Bot., **33**, 22. 1976

***Myelochroa degelii* (Hale) Elix & Hale, comb. nov.**

Basionym: *Parmelina degelii* Hale, Smithsonian Contrib. Bot., **33**, 25. 1976

***Myelochroa denegans* (Nyl.) Elix & Hale, comb. nov.**

Basionym: *Parmelia denegans* Nyl., Acta Soc. Sc. Fenn., **26**, 6. 1900

***Myelochroa entotheiochroa* (Hue) Elix & Hale, comb. nov.**

Basionym: *Parmelia entotheiochroa* Hue, Nouv. Arch. Mus. Paris ser. 3, **1**, 161. 1899

***Myelochroa galbina* (Ach.) Elix & Hale, comb. nov.**

Basionym: *Parmelia galbina* Ach., Syn. Meth. Lich., 195. 1814

***Myelochroa hayachinensis* (Kurok.) Elix & Hale, comb. nov.**

Basionym: *Parmelia hayachinensis* Kurok., J. Jap. Bot., **43**, 350. 1968

***Myelochroa immiscens* (Nyl.) Elix & Hale, comb. nov.**

Basionym: *Parmelia immiscens* Nyl., Flora, Jena **68**, 606. 1885

Myelochroa indica (Hale) Elix & Hale, comb. nov.

Basionym: *Parmelina indica* Hale, Smithsonian Contrib. Bot., **33**, 34. 1976

Myelochroa irrugans (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia irrugans* Nyl., Lich. Japon., **26**. 1890

Myelochroa leucotyliza (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia leucotyliza* Nyl., Lich. Japon., **27**. 1890

Myelochroa lindmanii (Lynge) Elix & Hale, comb. nov.

Basionym: *Parmelia lindmanii* Lynge, Arkiv Bot., **13**, 74. 1914

Myelochroa metarevoluta (Asahina) Elix & Hale, comb. nov.

Basionym: *Parmelia metarevoluta* Asahina, J. Jap. Bot., **35**, 97. 1960

Myelochroa obsessa (Ach.) Elix & Hale, comb. nov.

Basionym: *Parmelia obsessa* Ach., Syn. Meth. Lich., 195. 1814

Myelochroa perisidians (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia perisidians* Nyl., Acta Soc. Sci. Fenn. **26**, 6. 1900

Myelochroa rhytidodes (Hale) Elix & Hale, comb. nov.

Basionym: *Parmelina rhytidodes* Hale, Smithsonian Contrib. Bot., **33**, 43. 1976

Myelochroa subaurulenta (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia subaurulenta* Nyl., Flora, Jena **68**, 606. 1885

Myelochroa xantholepis (Mont. & v.d. Bosch) Elix & Hale, comb. nov.

Basionym: *Parmelia xantholepis* Mont. & v.d. Bosch, in F. Junghuhn, Plantae Junghuhnianae, 428. 1855

Parmelinella Elix & Hale, gen. nov.

Thallus foliaceus, adnatus, pagina superiore epicorticata, cinerea, emaculata, atranorinum et chloroatranorinum continens; lobis irregularibus, 4-10 mm latis, apice rotundatis, margine ciliatis, ciliis brevibus, angustatis, sparsis in axillis loborum; pagina inferior nigra, rhizinis simplicibus parvis vel sparsis. Apothecia adnata, imperforata, sporis octonis, ellipsoideis, 8-10 x 15-18 μ m. Pycnidia laminalia, conidiis cylindricis, 5-9 μ m longis.

Typus generis: *Parmelia wallichiana* Taylor, Hooker J. Bot., **6**, 176. 1847

[*Parmelinella wallichiana* (Taylor.) Elix & Hale]

Thallus foliose, corticolous or saxicolous, coriaceous, adnate, lobes irregular, broad, (3-)4-10 mm wide, apices rotund, margins ciliate, cilia sparse, more or less restricted to the axils, simple, slender. Upper surface grey, emaculate, with a perforate polysaccharide covering. Underside black, with a relatively broad bare or papillate marginal zone, moderately to sparsely rhizinate, rhizines simple. Apothecia adnate, imperforate, spores ellipsoid, simple, 8 per ascus, 8-10 x 15-18 μ m. Pycnidia laminal, conidia cylindrical, 5-9 μ m long. The upper cortex thick, coriaceous, containing atranorin and chloroatranorin, $\pm$ traces of secalonic acid.

The genus currently contains the following species:

Parmelinella manipurensis (Singh) Elix & Hale, comb. nov.

Basionym: *Parmelina manipurensis* Singh, Bryologist, **83**, 533. 1980

Parmelinella simplicior* (Hale) Elix & Hale, comb. nov.**Basionym: *Parmelia simplicior* Hale, Bryologist, **75**, 99. 1972Parmelinella wallichiana* (Taylor) Elix & Hale, comb. nov.**Basionym: *Parmelia wallichiana* Taylor, Hooker J. Bot., **6**, 176. 1847***Parmelinopsis* Elix & Hale, gen. nov.**

Thallus foliaceus, adnatus vel laxe adnatus, pagina superiore epicorticata, cinerea, emaculata, atranorinum et chloroatranorinum continens; lobis sublinearibus, apice truncatibus, margine ciliatis, ciliis $\pm$ elongatis, angustatis, densis vel sparsis; pagina inferior nigra, rhizinis simplicibus vel furcatis instructa. Apothecia adnata, imperforata, sporis octonis, ellipsoideis, 8-12 x 12-18 μm . Pycnidia laminalia, conidiis bifusiformibus vel cylindricis, brevibus, 3-5 μm longis.

Typus generis: *Parmelia horrescens* Taylor in J. T. Mackay, Flora Hibern., 144. 1836
[*Parmelinopsis horrescens* (Taylor) Elix & Hale]

Thallus foliose, corticolous or less commonly saxicolous, adnate to loosely adnate, lobes sublinear-elongate, dichotomously or irregularly divided, narrow, 0.5-1.5 (-3.0) mm wide, apices truncate, margins ciliate, cilia dense to sparse, more or less evenly distributed, simple, slender. *Upper surface* grey, sometimes darkening with age, with a perforate polysaccharide covering. *Underside* black, moderately to densely rhizinate, rhizines simple or sparsely furcate and dichotomously branched. *Apothecia* adnate, imperforate, spores ellipsoid, simple, with thick walls, 8 per ascus, 8-12 x 12-18 μm . *Pycnidia* laminal, conidia cylindrical or bifusiform, 3-5 μm long. The upper cortex containing atranorin and chloroatranorin.

The genus currently contains the following species:

Parmelinopsis afrorevoluta* (Krog & Swinsc.) Elix & Hale, comb. nov.**Basionym: *Parmelia afrorevoluta* Krog & Swinsc., Norw. J. Bot., **26**, 22. 1979Parmelinopsis cryptochlora* (Vainio) Elix & Hale, comb. nov.**Basionym: *Parmelia cryptochlora* Vainio, J. Bot. Brit. & For., **34**, 34. 1896***Parmelinopsis damaziana* (Zahlbr.) Elix & Hale, comb. nov.**Basionym: *Parmelia damaziana* Zahlbr., Bull. Herb. Boiss., ser. 2, **5**, 541. 1905***Parmelinopsis expallida* (Kurok.) Elix & Hale, comb. nov.**Basionym: *Parmelia expallida* Kurok., Bull. Nat. Sc. Mus., Tokyo **11**, 191. 1968***Parmelinopsis heteroloba* (Zahlbr.) Elix & Hale, comb. nov.**Basionym: *Parmelia heteroloba* Zahlbr., Denks. Akad. Wiss. Wien Math.-Natur.
Klasse, **83**, 171. 1909***Parmelinopsis horrescens* (Taylor) Elix & Hale, comb. nov.**Basionym: *Parmelia horrescens* Taylor in J. T. Mackay, Flora Hibern., 144. 1836***Parmelinopsis jamesii* (Hale) Elix & Hale, comb. nov.**Basionym: *Parmelia jamesii* Hale, Phytologia, **23**, 179. 1972***Parmelinopsis melanochaeta* (Kurok.) Elix & Hale, comb. nov.**Basionym: *Parmelia melanochaeta* Kurok., in Hale & Kurokawa, Contrib. U.S. Nat.
Herb., **36**, 133. 1964***Parmelinopsis microlobulata* (Awes.) Elix & Hale, comb. nov.**Basionym: *Parmelia microlobulata* Awes., Biological Memoirs, **1**, 182. (1976) 1977

Parmelinopsis minarum (Vainio) Elix & Hale, comb. nov.

Basionym: *Parmelia minarum* Vainio, Acta Soc. Faun.-Flora Fenn., **7**, 48. 1890

Parmelinopsis neodamaziana (Elix & Johnston) Elix & Hale, comb. nov.

Basionym: *Parmelina neodamaziana* Elix & Johnston, Brunonia, **9**, 155. 1987

Parmelinopsis pindarensis (Awat. & S. Singh) Elix & Hale, comb. nov.

Basionym: *Parmelia pindarensis* Awat. & S. Singh, Biological Memoirs, **1**, 185. (1976) 1977.

Parmelinopsis radiculata (Kurok.) Elix & Hale, comb. nov.

Basionym: *Parmelia radiculata* Kurok., Studies of Cryptogams of Papua New Guinea, **139**. 1979

Parmelinopsis schindleri (Hale) Elix & Hale, comb. nov.

Basionym: *Parmelina schindleri* Hale, Smithsonian Contrib. Bot., **33**, 44. 1976

Parmelinopsis spathulata (Kurok.) Elix & Hale, comb. nov.

Basionym: *Parmelia spathulata* Kurok., in Hale & Kurokawa, Contrib. U.S. Nat. Herb., **36**, 133. 1964

Parmelinopsis spumosa (Asahina) Elix & Hale, comb. nov.

Basionym: *Parmelia spumosa* Asahina, J. Jap. Bot., **26**, 259. 1951

Parmelinopsis subfatiszens (Kurok.) Elix & Hale, comb. nov.

Basionym: *Parmelia subfatiszens* Kurok., in Hale & Kurokawa, Contrib. U.S. Nat. Herb., **36**, 134. 1964

Parmelinopsis swinscowii (Hale) Elix & Hale, comb. nov.

Basionym: *Parmelia swinscowii* Hale, Phytologia, **27**, 4. 1973

Parmotremopsis Elix & Hale, gen. nov.

Thallus foliaceus, adnatus, pagina superiore epicorticata, cinerea, emaculata, atranorinum et chloroatranorinum continens; lobis irregularibus, 4-10 mm latis, apice rotundatis, margine ciliatis, ciliis brevibus, angustatis, sparsis in axillis loborum; pagina inferior nigra, rhizinis simplicibus parvis vel densis. Apothecia adnata, imperforata, sporis octonis, ellipsoideis, 3-6 x 7-8 μm . Pycnidia laminalia, conidiis cylindricis, brevibus, 3-5 μm longis.

Typus generis: *Parmelia antillensis* Nyl., Bull. Soc. Linn. Normand., **6**, 264. 1868

[*Parmotremopsis antillensis* (Nyl.) Elix & Hale]

Thallus foliose, corticolous, thin, fragile, adnate to the apices, *lobes* irregular, broad, (3-)-4-10 mm wide, apices rotund, margins ciliate, *cilia* sparse, more or less restricted to the axils, simple, slender. *Upper surface* grey, emaculate, with a perforate polysaccharide covering. *Underside* black, with a very narrow bare or papillate marginal zone, moderately to densely rhizinate, rhizines simple. Apothecia adnate, imperforate, spores ellipsoid, simple, 8 per ascus, 3-6 x 7-8 μm . Pycnidia laminal, conidia cylindrical, 3-5 μm long. The upper cortex $\pm$ flaking, containing atranorin and chloroatranorin.

Parmotremopsis antillensis (Nyl.) Elix & Hale, comb. nov.

Basionym: *Parmelia antillensis* Nyl., Bull. Soc. Linn. Normand., **6**, 264. 1868

Parmotremopsis phlyctina (Hale) Elix & Hale, comb. nov.
 Basionym: *Parmelia phlyctina* Hale, Bryologist, **62**, 129. 1959

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SCHISTOPLACA (LICHENES, BIATORACEAE),
A NEW LICHEN GENUS

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ABSTRACT

A new lichen genus, *Schistoplaca* (Lichenes, Biatraceae), is described from southern Africa. The genus is typified by a new species, *S. alvearialis*, which grows on limestone near Bredasdorp, in the south-western Cape. The affinities of this new genus are discussed.

SCHISTOPLACA Brusse, *gen. nov.*

Lichen ad Biatraceas (Ascomycetes, Lecanorales) pertinens. Thallus crustosus, saxicola. *Apothecia* lecanorina, sessilia. *Excipulum thallinum* bene evolutum, cortice obscure paraplectenchymato. *Excipulum* (proprium) tenue, hyalinum, compactum, cellulis isodiametris vel brevibus. *Hypothecium* hyalinum, crassum, inspersum, compactum, cellulis isodiametris vel brevibus. *Hymenium* hyalinum, J+ caeruleum. *Paraphyses* septatae, simplices vel leviter ramosae, conglutinatae, leviter capitatae vel cylindricae. *Asci* clavati, cum tholis J+ caeruleis, ut in iconem (figura 2) illustrati. *Ascospores* octonae, hyalinae, simplices, ellipsoideae. *Pycnidia* hyalina, sphaerica, immersa. *Pycnidiosporophora* ut in *Lecanora*. *Pycnidiosporae* filiformes, acrogenae, parabolice falcatae, hyalinae, flexiles.

TYPUS: *Schistoplaca alvearialis* Brusse.

Lichen belonging to the Biatraceae (Ascomycetes, Lecanorales). Thallus crustose, saxicolous. *Apothecia* lecanorine, sessile. *Thalline exciple* well developed, cortex indistinctly paraplectenchymatous. *Exciple* (proper) thin, hyaline, compact, cells isodiametric or short. *Hypothecium* hyaline, inspersed, compact, thick, cells isodiametric or short. *Hymenium* hyaline, J+ blue. *Paraphyses* septate, simple to lightly branched conglutinate, lightly capitate or cylindrical. *Asci* clavate, eight-spored, tholus J+ blue as in illustration (figure 2). *Ascospores* hyaline, simple, ellipsoid. *Pycnidia* hyaline, sphaerical, immersed. *Pycnidiosporophores* as in *Lecanora* (Hertel & Rambold, 1985). *Pycnidiospores* filiform, apical, falcate, hyaline, flexible.

Etymology: The genus name is derived from the Greek schistos (σχιστος) meaning cleft or divided, and (the plural of) plax (πλαξ) meaning anything flat.

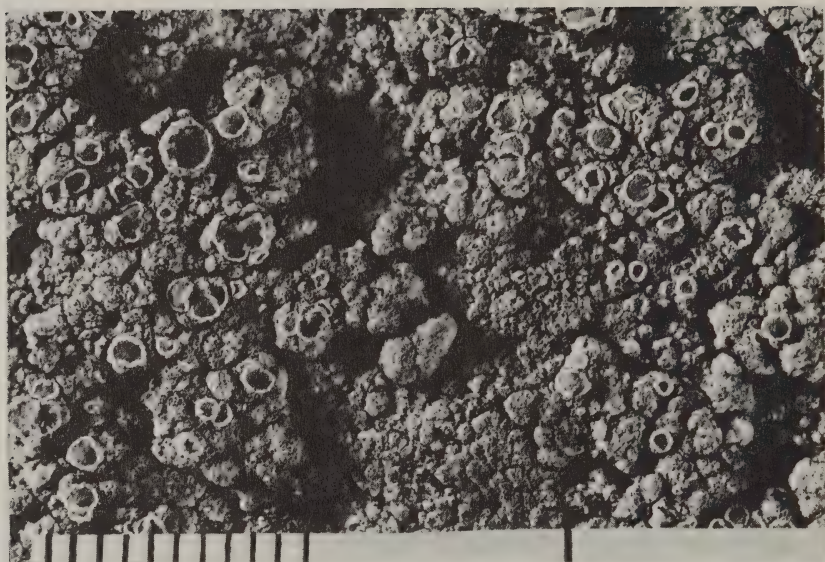


Fig. 1. *Schistoplaca alvearialis* Brusse, habit. *F. Brusse 3816*, holotype. Scale in mm.

SCHISTOPLACA ALVEARIALIS Brusse, *sp. nov.*

Thallus crustosus, calcicola, cinereus, usque ad 8 cm diametro, 0.2–1.0 mm crassus, sine hypothallum. *Superficies* cinerea, leviter rimosa, crystallis (oxalas calcii) immersis punctata. *Cortex* circa 200 μ m crassus, obscure paraplectenchymatus, cellulis 3.5–6.0 μ m diametro, crystallis grandibus (oxalas calcii), 100–200 μ m diametro, inclusens. *Stratum gonidiale* 20–50 μ m crassum, algas *Trebouxias*, 5–18 μ m diametro continens. *Medulla* alba, 0–800 μ m crassa, crystallis grandibus (oxalas calcii) sparse inspersa, hyphis 1.5–2.5 μ m crassis. *Apothecia* numerosa, lecanorina, emergentia vel sessilia, 0.3–2.0 mm diametro, superficiebus hymeniorum porphyreis, pruinosis. *Excipulum thallinum* bene evolutum, cortice 15–20 μ m crasso. *Excipulum* circa 20 μ m crassum J-. *Hypothecium* 200–250 μ m crassum, J-. *Hymenium* 70–80 μ m altum. *Paraphyses* 1.0–1.4 μ m crassae, capitibus usque ad 1.7 μ m crassis. *Asci* clavati, 45–50 $\times$ 12–18 μ m, tholis J+ caeruleis (figura 2). *Ascosporae* octonae, hyalinae, simplices, late ellipsoideae vel subsphaericae, 7.5–10 $\times$ 6.5–8.5 μ m. *Pycnidia* circa 150 μ m diametro. *Pycnidiosporae* hyalinae, parabolice falcatae ($\frac{1}{2}\lambda$), 12–22 $\times$ 1 μ m. *Thallus* atranorinum et/vel chloroatranorinum, et zeorinum continens.

TYPUS: SOUTH AFRICA, SW CAPE PROVINCE, Bredasdorp district near Mierkraal, Die Poort (Heuningnes River Valley), on S facing sandy limestone kranz, alt. 30–60 m. *F. Brusse 3816*, 1981.05.14 (PRE, holo-; BM, CBG, COLO, E, LD, LG, MEL, NU, S, UPS, US, iso-).

Thallus crustose, on limestone, pale olive-grey, up to 8 cm across, 0.2–1.0 mm thick, hypothallus not visible. *Surface* pale olive-grey, lightly rimose, punctate with immersed crystals (calcium oxalate). *Cortex* about 200 μ m thick, indistinctly paraplectenchymatous, cells 3.5–6.0 μ m diam., embedding large (calcium oxalate) crystals, 100–200 μ m diam. *Algal layer* 20–50 μ m thick, algae *Trebouxia*, 5–18 μ m diam.

Medulla white, 0–800 μm thick, sparsely interspersed with large (calcium oxalate) crystals, hyphae 1.5–2.5 μm thick. *Apothecia* numerous, lecanorine, emergent to sessile, 0.3–2.0 mm across, hymenial surface reddish-brown, pruinose. *Thalline exciple* well developed, cortex 15–20 μm thick. *Exciple* circa 20 μm thick, J–. *Hypothecium* 200–250 μm thick, J–. *Hymenium* 70–80 μm high. *Paraphyses* 1.0–1.4 μm thick, heads up to 1.7 μm thick. *Asci* clavate, eight-spored, 45–50 $\times$ 12–18 μm , tholus J+ blue (figure 2). *Ascospores* hyaline, simple, broadly ellipsoid to subsphaerical, 7.5–10 $\times$ 6.5–8.5 μm . *Pycnidia* around 150 μm diam. *Pycnidiospores* hyaline, parabolically falcate ($\frac{1}{2}$ λ), 12–22 $\times$ 1 μm . *Chemistry*: atranorin and/or chloroatranorin and zeorin present.

Etymology: the epithet *alvearialis* is derived from the Latin 'alvearium' meaning 'beehive', and the suffix '-alis', meaning 'pertaining to'. The name therefore means, 'pertaining to beehives', in allusion to the many beehives present in the hollows in the limestone on which this new species grows.

This new genus is a member of the Biatraceae (Hafellner 1984), as is evidenced by the tholus reaction in Lugol's iodine solution (figure 2). The genus is probably most closely related to *Herteliana* P. James, but this genus lacks a thalline exciple, has a well developed paraplectenchymatous exciple, and a hypothecium with radiately arranged hyphae (James 1980).

Schistoplaca alvearialis resembles *S. argopholis* (Ach.) Brusse* in outward appearance (fig. 1), except for the pruinose hymenium, and the less bullate thallus. *S. argopholis* is also biatorine in tholus structure, but the ascospores are more normally ellipsoid and larger, and the thalline upper cortex is thinner. *S. argopholis* contains atranorin and zeorin in common with this new species, but consistently contains (five specimens tested) the yellow pulvinic acid derivative, epanorin (Santesson 1969, Huneck & Schreiber 1974), and two aliphatic acids in addition. Atranorin and several fatty acids were regarded as diagnostic for *S. argopholis* (Vänskä 1984), and this contrasts clearly with *S. alvearialis*, where fatty acids were not detected (TLC). Chloroatranorin was tentatively identified in *S. alvearialis* by the dark colour in longwave ultra-violet light, whereas atranorin is barely visible in this light.

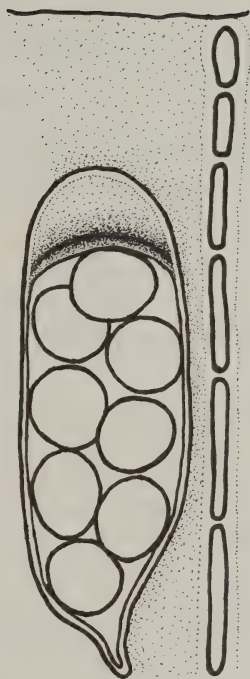


Fig. 2. *Schistoplaca alvearialis* Brusse, ascus and paraphysis. F. Brusse 3816, holotype. Bar = 10 μm .

* *Schistoplaca argopholis* (Ach.) Brusse comb. nov.

Basionym: *Parmelia atra* β P. *argopholis* Ach. Meth. Lich. suppl. 32. 1803.

Synonym: *Lecanora argopholis* (Ach.) Ach. Lich. Univ. 346. 1810.

It is quite probable that several other new combinations will have to be made in this genus. Recently several species in this group were dealt with, including two new ones (Vänskä 1986). However the group as treated there is probably heterogeneous, some species being unrelated to *Schistoplaca argopholis*. A critical examination of the asci in conjunction with the pycnidia and the pycnidiosporogenous cells, will probably reveal some additional combinations in this new genus. All the species treated by Vänskä (1986) have normally ellipsoid ascospores, 4–7 μm wide. The apothecia of the group treated are also smaller being around 1 mm in diameter.

Schistoplaca alvearialis is presently known from the Gansbaai–Bredasdorp area of the south-western Cape, near the southernmost tip of Africa, Cape Agulhas. The distribution is restricted to the occurrence of limestone outcrops, the substrate of this new species.

SPECIMENS EXAMINED

SOUTH AFRICA, CAPE—**3419** (Caledon): Gansbaai area, Byneskranskop near Strandskloof overlooking the Uilkraals River Valley on a SE sandy limestone kranz (—CB), *F. Brusse* 3850, 1981.05.14 (BM, COLO, LD, PRE).

Schistoplaca argopholis (Ach.) Brusse

AUSTRIA.—**4614**: Auf Chloritschiefer nördlich von Ziguln bei Klagenfurt. *Steiner s.n.*, 1887 (Arn., Lich. Exs. 1224, PRE CH3279).—**4815**: Ad saxa schistosa prope Krems, 200–400 M.s.m. *J. Baumgartner s.n.* (Krypt. Exs. Vind. 50, PRE CH514); An Amphibolschieferfelsen bei der Kremser Vorstadt Kremsthal. *Baumgartner s.n.*, 1898 (Arn., Lich. Exs. 1775, PRE CH3819).

HUNGARY.—**4719**: Auf Blöcken von barythaltigem Thonkiesel auf dem Gipfel des Blocksberges (Gellérthegey) bei Budapest, Ungarn. *Lojka s.n.*, 23 September 1886 (Arn., Lich. Exs. 1162, PRE CH3219)

RUMANIA.—**4425**: Ad saxa in monte S. Gerardi ad Budam. *Lojka s.n.* (Flora Exsiccata Austro-Hungarica 346, PRE CH48).

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ADDITIONS TO THE *XANTHOPARMELIA* FLORA OF SOUTHERN
AFRICA (LICHENIZED ASCOMYCOTINA: PARMELIACEAE)*

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Abstract. Twenty-four new species of the lichen genus *Xanthoparmelia* are described from southern Africa: *X. areolata* Hale, *X. beatricea* Hale, *X. brevilobata* Hale, *X. contrasta* Hale, *X. coriacea* Hale, *X. diffractaica* Hale, *X. eruptens* Hale, *X. inconspicua* Hale, *X. laciniata* Hale, *X. latilobata* Hale, *X. laxchalaybaeizans* Hale, *X. natalensis* Hale, *X. neoeptans* Hale, *X. neoweberi* Hale, *X. pachyclada* Hale, *X. paradoxa* Hale, *X. perrugosa* Hale, *X. protodysprosa* Hale, *X. proximata* Hale, *X. rubropustulata* Hale, *X. subpallida* Hale, *X. swartbergensis* Hale, *X. umtamvuna* Hale, and *X. vendensis* Hale. Two species, *X. arida* Egan & Derstine and *X. keralensis* Hale, are reported as new for southern Africa.

Xanthoparmelia areolata Hale, sp. nov.

Fig. 1

Thallus subcrustosus, saxicola, 5–8 cm latus, lobis subirregularibus, 0.5–1 mm latis, superne emaculatus, isidiatis, isidiis globosis, fragilibus, subtus planus, pallide brunneus, modice rhizinosus.

Thallus subcrustose to tightly adnate on rock, 5–8 cm broad, light yellow green; lobes subirregular, 0.5–1 mm wide, contiguous to scattered, forming areolate patches; upper surface continuous, shiny, emaculate, transversely cracked with age, sparsely isidiate, the isidia globose, fragile, breaking open and becoming pustulate, 0.2–0.3 mm in diameter, 0.2–0.3 mm high; lower surface plane, pale brown, moderately rhizinate, the rhizines simple, pale brown, 0.1–0.2 mm long.

Pycnidia and apothecia lacking.

Chemistry: barbatic, 4-O-demethylbarbatic and usnic acids.

Type collection: On sandstone ledges at junction of Hwy N1 and Njelele Dam Road, N. of Louis Trichardt, elev. 660 m, Transvaal, S. Africa, Grid 2229 DD, M. E. Hale 76267, 25 Sept. 1986 (US, holotype; ANUC, PRE, isotypes).

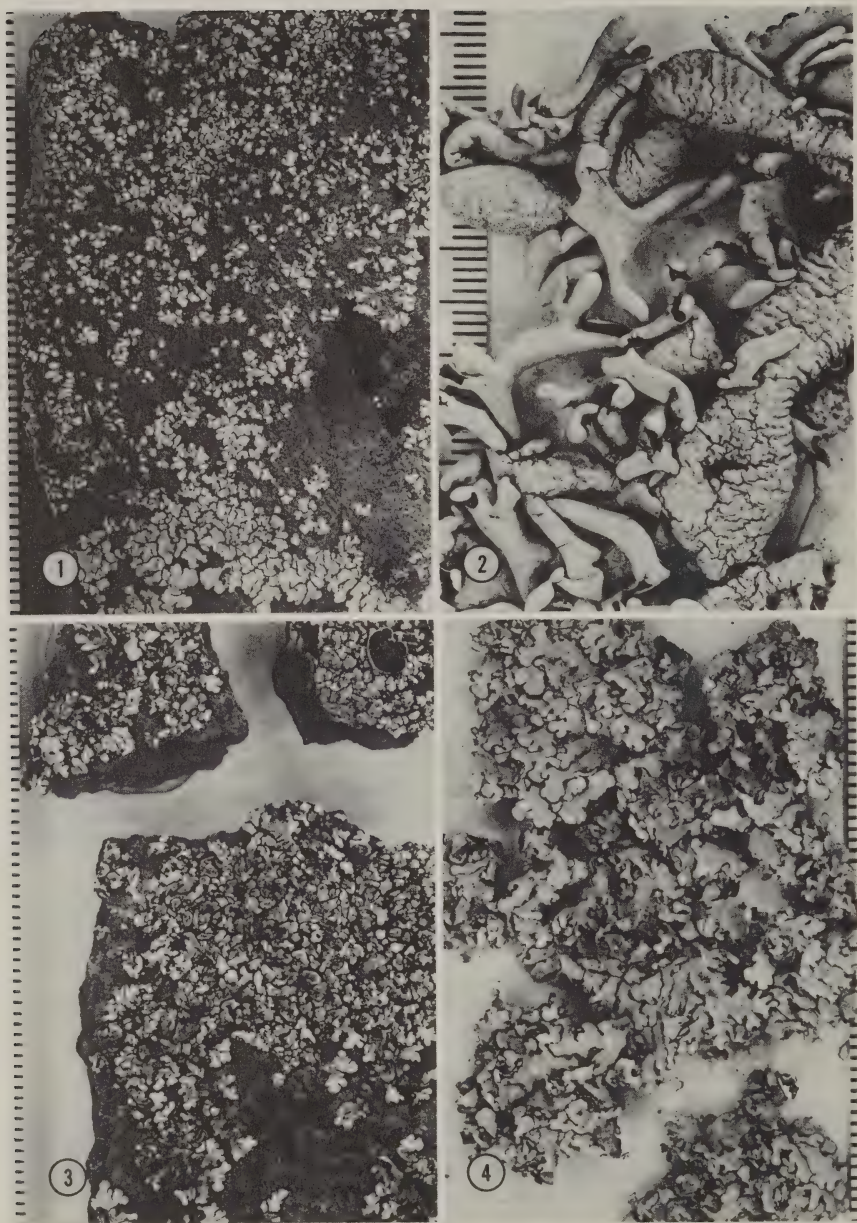
Additional specimens examined. Same locality as the holotype, Hale 76295, 76305 (US).

Xanthoparmelia centralis Elix & Johnston from Australia has the same chemistry but the lobes are broader (to 1.5 mm wide) and the isidia smaller.

Xanthoparmelia arida Egan & Derstine, Bryol. 81:607. 1978.

There are three lecanoric acid-containing species in southern Africa: *X. lecanorica* (Hale) Hale (adnate with a black lower surface) and *X. namaquensis* Hale (adnate to loosely adnate with a black lower surface and an unidentified anthraquinone pigment in addition to lecanoric acid), both found only in Namaqualand in eastern Cape Province, and *X. worcesteri* (Stein. & Zahlbr.) Hale

*Field studies were supported by a grant from the Scholarly Studies Program, Smithsonian Institution. I am indebted to Dirk Wessels, University of the North, Sovenga, S. Africa, for arranging trips to several sites in Transvaal and Venda.



Figures 1-4. Holotypes of *Xanthoparmelia*: 1, *X. areolata*; 2, *X. beatricea*; 3, *X. brevilobata*; 4, *X. contrasta*. Scale in mm.

(subcrustose to tightly adnate with a pale lower surface), a common lichen throughout the karoo of Cape Province. This newly reported fourth species, previously known only from Texas in U.S.A., is adnate and has a pale brown lower surface. It is a rarely collected Namaqualand lichen.

Specimens examined. S. Africa. Cape Province: 19.5 km N of Vanrhynsdorp on hwy N7, Grid 3118 BC, *Hale* 73194 (US); 36.4 km N of Vanrhynsdorp on hwy N7, Grid 3118 BC, *Hale* 72217 (US); 53 km W of Williston on hwy R63, Grid 3120 AD, *Hale* 78541 (US).

***Xanthoparmelia beatricea* Hale, sp. nov.**

Fig. 2

Thallus laxe adnatus, terricola, 6–10 cm latus, lobis sublinearibus, 4–10 mm latis, coriaceis, separatis, superne emaculatus, isidiis sorediisque destitutus, subtus valde convolutus, sparse rhizinosus.

Thallus free growing on soil, firm and leathery, 6–10 cm broad but scattered over several meters, light yellow green; lobes sublinear, 4–10 mm wide when expanded, little branched, 1–4 cm long, twisted and contorted; upper surface continuous, dull, emaculate, becoming strongly rugose with age; isidia and soredia lacking; lower surface strongly convoluted, forming tubelike branches, sparsely to moderately rhizinate, the rhizines brown, simple to sparsely furcate, 0.3–0.5 mm long.

Pycnidia rarely developed; conidia cylindrical, $0.5 \times 9\text{--}12\ \mu\text{m}$. Apothecia lacking.

Chemistry: Protocetraric and usnic acids.

Type collection: On soil in grazed karoo, 5 km NE of Hwy N7 on the Douse-the-Glim road at the railroad crossing, elev. 200 m, Cape Province, S. Africa, Grid 3118 BC, M. E. Hale 78606, 30 Oct. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

When turned over, the lower side of this rare soil lichen is exactly like the upper side because of the strong lobe convolution, similar to the habit of the Australian *X. convoluta* (Krempf.) Hale, *X. pachyclada* Hale (below) and the so-called vagrant forms of *X. camtschadalis* (Ach.) Hale. It is also unusual in having by far the longest conidia that I have measured in the genus. The species is named after my wife, who discovered it in the knersvlakte region of Namaqualand.

***Xanthoparmelia brevilobata* Hale, sp. nov.**

Fig. 3

Thallus adnatus, saxicola, 5–8 cm latus, lobis subirregularibus, brevibus, 1–2 mm latis, superne emaculatus, medulla pro parte ochracea, subtus planus, brunneus, sparse rhizinosus.

Thallus adnate on rocks, coriaceous, 5–8 cm broad, dark yellowish green; lobes subirregular, 1–2 mm wide, short and crowded, contiguous to imbricate and bullate-laciniate in older parts; upper surface continuous, shiny, emaculate, transversely cracked in older parts; isidia and soredia absent; lower part of medulla ochre; lower surface plane, shiny, brown and partly tinged with ochre, sparsely to moderately rhizinate, the rhizines brown, simple, 0.1–0.3 mm long.

Pycnidia common; conidia bifusiform, 4–5 μm . Apothecia well developed, adnate, 3–5 mm in diameter, the disc plane; hymenium 45–48 μm ; spores $6 \times 8\text{--}9\ \mu\text{m}$.

Chemistry: Hypostictic, hyposalazinic and usnic acids, with PQ-4 unknown and skyrin.

Type collection: On sheltered basaltic rocks in escarpment, Naudesnek, elev. 2180 m, Cape Province, S. Africa, Grid 3028 CB, M. E. Hale 76866, 9 Oct. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

Externally this rare species resembles *X. subcrustacea* (Gyel.) Elix & Johnston from Australia. Both contain the hypostictic acid complex but *X. subcrustacea* lacks skyrin and has a thinner thallus.

***Xanthoparmelia contrasta* Hale, sp. nov.**

Fig. 4

Thallus laxe adnatus, saxicola, 5–8 cm latus, lobis subirregularibus vel sublinearibus, brevibus, 1.5–2 mm latis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, niger, sparse rhizinosus.

Thallus adnate to loosely adnate on rock, 5–8 cm broad, light yellowish green; lobes subirregular to sublinear, 1.5–2 mm wide, short, dichotomously branched, imbricate; upper surface continuous, shiny, emaculate; isidia and soredia lacking; lower surface plane, shiny, black, sparsely to moderately rhizinate, the rhizines dark brown to black, simple, 0.3–0.4 mm long.

Pycnidia and apothecia lacking.

Chemistry: hypoprotocetraric, 4-O-demethylnotatic and usnic acids, skyrin.

Type collection: On open sandstone ledges, on west side of Hwy R43, 17.4 km N of N2, N of Floorshoogte, elev. 350 m, Cape Province, S. Africa, Grid 3419 AB, M. E. Hale 78367, 26 Oct. 1986 (US, holotype; PRE, isotype).

Additional specimen examined. S. Africa. Cape Province: Swartberg Pass, Grid 3322 AC, Hale 78059 (US).

The only related species with hypoprotocetraric acid, *X. tablensis* Hale, has longer, separate to loosely imbricate lobes 1–2.5 mm wide and lacks skyrin.

***Xanthoparmelia coriacea* Hale, sp. nov.**

Fig. 5

Thallus adnatus, saxicola, coriaceus, 6–10 cm latus, lobis subirregularibus, apice rotundatis, 2–4 mm latis, superne emaculatus, isidiis sorediisque destitutus, medulla pro parte ochracea, subtus planus, modice rhizinosus.

Thallus adnate on rock, firm and leathery, 6–10 cm broad, yellowish green; lobes subirregular, apically rotund, 2–4 mm wide, short, contiguous; upper surface continuous, shiny, emaculate; isidia and soredia lacking; medulla in part ochre; lower surface plane, black, moderately rhizinate, the rhizines rather coarse, simple, black, 0.3–0.5 mm long.

Pycnidia common; conidia bifusiform, 5–6 μm . Apothecia abundant, substipitate, 2–8 mm in diameter; hymenium 48–52 μm ; spores 5–6 $\times$ 8–10 μm .

Chemistry: Traces of constipatic and protoconstipatic acids, an unidentified fatty acid, skyrin and usnic acid.

Type collection: On exposed basaltic outcrops at the escarpment, Naudesnek, elev. 2180 m, Cape Province, S. Africa, Grid 3028 CB, M. E. Hale 76870, 9 Oct. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimen examined. Same locality as the holotype, Hale 76853 (US).

A member of the *X. subdeciptiens* (Vain.) Hale series, *X. coriacea* is distinguished by the leathery thallus, the first occurrence of skyrin in a species with a fatty acid and the black lower surface. Of the other species with a black lower surface, *X. aliphatica* Hale has much broader, more membranous lobes (3–6 mm wide), *X. laciniata* Hale (below) has narrower, lacinate lobes, and *X. subnigra* Hale has narrow sublinear lobes (1–2.5 mm wide).

***Xanthoparmelia diffractaica* Hale, sp. nov.**

Fig. 6

Thallus adnatus vel laxe adnatus, saxicola, coriaceus, 6–8 cm latus, lobis subirregularibus, 2–5 mm latis, nigromarginatis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, pallide brunneus vel brunneus, modice rhizinosus.

Thallus adnate to loosely adnate on rock, leathery, 6–8 cm broad, dark yellowish green; lobes subirregular, 2–5 mm wide, apically rotund, contiguous to subimbricate, black rimmed; upper surface continuous, shiny, emaculate, irregularly cracked with age, isidia and soredia lacking; lower surface plane, pale brown to brown, moderately to densely rhizinate, the rhizines pale brown, simple, 0.5–1 mm long.

Pycnidia common; conidia bifusiform, 5–6 μm . Apothecia abundantly developed, adnate to substipitate, 2–7 mm in diameter; hymenium 44–48 μm ; spores 5–6 $\times$ 9–11 μm .

Chemistry: Salazinic, diffractaic and usnic acids.

Type collection: On exposed basaltic outcrops at the escarpment, Naudesnek, elev. 2180 m, Cape Province, S. Africa, Grid 3028 CB, M. E. Hale 76885, 9 Oct. 1986 (US, holotype; PRE, isotype).

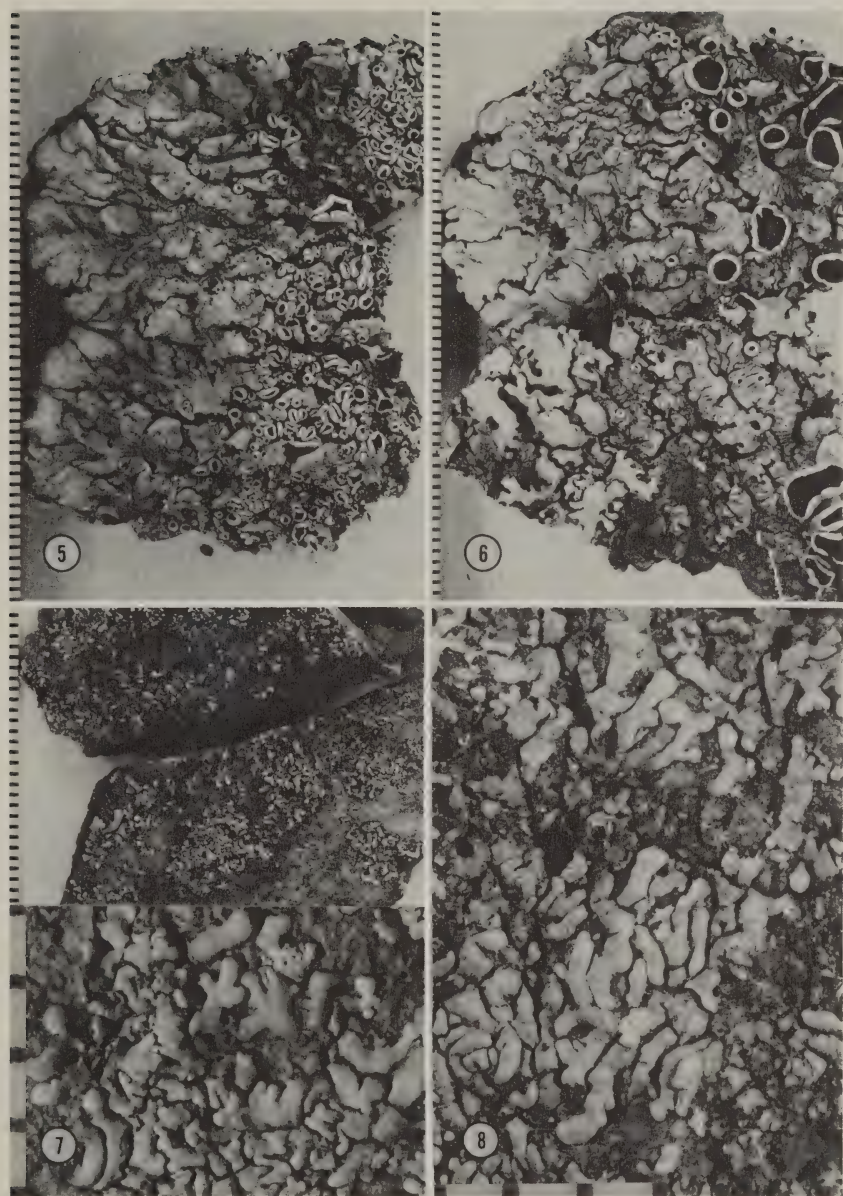
Another high elevation species with this chemistry from the high Drakensberg escarpment, *X. lesotoensis* Hale, is smaller and more closely adnate with narrow lobes 1–2 mm wide.

***Xanthoparmelia eruptens* Hale, sp. nov.**

Fig. 7

Thallus arcte adnatus, saxicola, 2–4 cm latus, lobis sublinearibus, 0.3–0.7 mm latis, superne emaculatus, isidiatus, isidiis globosis, eruptentibus, subtus planus, niger, sparse rhizinosus.

Thallus nearly subcrustose to tightly adnate on rock, 2–4 cm broad, dull yellowish green; lobes sublinear, 0.3–0.7 mm wide, little branched, separate to contiguous, 1–2 mm long; upper surface continuous, shiny, emaculate, isidiate, the isidia coarse, globose, fragile and erupting apically but not becoming sorediate, 0.2–0.3 mm in diameter; lower surface plane, shiny, black, sparsely rhizinate,



Figures 5-8. Holotype of *Xanthoparmelia*: 5, *X. coriacea*; 6, *X. diffractaica*; 7, *X. eruptens*; 8, *X. inconspicua*. Scale in mm.

the rhizines simple, black, 0.1–0.2 mm long.

Pycnidia and apothecia lacking.

Chemistry: Evernic, lecanoric and usnic acids.

Type collection: On lower side of large vertical cliff, Table Mountain sandstone, Uitkyk Pass, Cederberg Mountains, elev. 900 m, Cape Province, S. Africa, Grid 3219 AC, M. E. Hale 78395, 29 Oct. 1986 (US, holotype; PRE, isotype).

There are only two other species in *Xanthoparmelia* with evernic and lecanoric acids: *X. equalis* Hale and *X. lecanoracea* (Müll. Arg.) Hale, both larger, nonisidiate species from Namibia/S.W.A.

***Xanthoparmelia inconspicua* Hale, sp. nov.**

Fig. 8

Thallus subcrustosa, saxicola, 3–6 cm latus, lobis sublinearibus, 0.3–0.5 mm latis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, cortice fragili, brunneus, modice rhizinosus.

Thallus subcrustose on rock, 3–5 cm broad, dull yellowish green; lobes sublinear, 0.3–0.6 mm wide, little branched, 1.5–2 mm long, separate to contiguous; isidia and soredia lacking; lower medulla rusty red in older parts; lower surface plane, the cortex thin and fragile, brown, moderately rhizinate, the rhizines brownish translucent, 0.1–0.2 mm long.

Pycnidia and apothecia lacking.

Chemistry: Hypostictic, hyposalazinic and usnic acids with PQ-4 unknown and unidentified dull reddish pigments.

Type collection: On open, S-facing sandstone ledges in pasture, on west side of hwy R43, 17.4 km N of N2, N of Floorshoogte, elev. 350 m, Cape Province, S. Africa, Grid 3419 AB, M. E. Hale 78097, 26 Oct. 1986 (US, holotype; PRE, isotype).

This rare species has no obvious relatives among the subcrustose or tightly adnate members of the genus. Not only is the hypostictic acid group ("quintaria unknowns") unusual in a subcrustose species but the fragile, thin lower cortex with translucent rhizines is distinctive.

***Xanthoparmelia keralensis* Hale, Mycotaxon 22:282, 1985.**

This isidiate species was based on a single collection from the state of Kerala in India. It can now be reported from several localities in the foothills of the Drakensberg Mountains from Transvaal southward to Natal. The revised chemistry (comm. Dr. J. A. Elix) is stenosporonic acid (major), colensoic acid (minor), divaronic acid (tr.), gyrophoric acid (tr.) and usnic acid. Dr. Elix has also found that this is the presumptive isidiate morph of *X. stenosporonica* Hale (Mycotaxon 27:598, 1986), a rare but widespread species in southern Cape Province and Transvaal.

Specimens examined. S. Africa. Venda: 2 km E of Holy Forest (Thathe Vanda), Grid 2230 BD, Hale 79156 (US). Transvaal: Mt. Sheba Nature Reserve, Grid 2430 DC, Hale 76114, 76143 (US); Mountain View Hotel, Soutpansberg Mountains, Grid 2229 DD, Hale 76312, 76314 (US). Natal: Bushman's Nek, Grid 2929 CB, Hale 76562 (US).

***Xanthoparmelia laciniata* Hale, sp. nov.**

Fig. 9

Thallus adnatus, saxicola, 7–10 cm latus, lobis sublinearibus, 0.5–1.2 mm latis, dense laciniatis, superne emaculatus, rugulosus aetate, isidiis sorediisque destitutus, subtus planus, sparse rhizinosus.

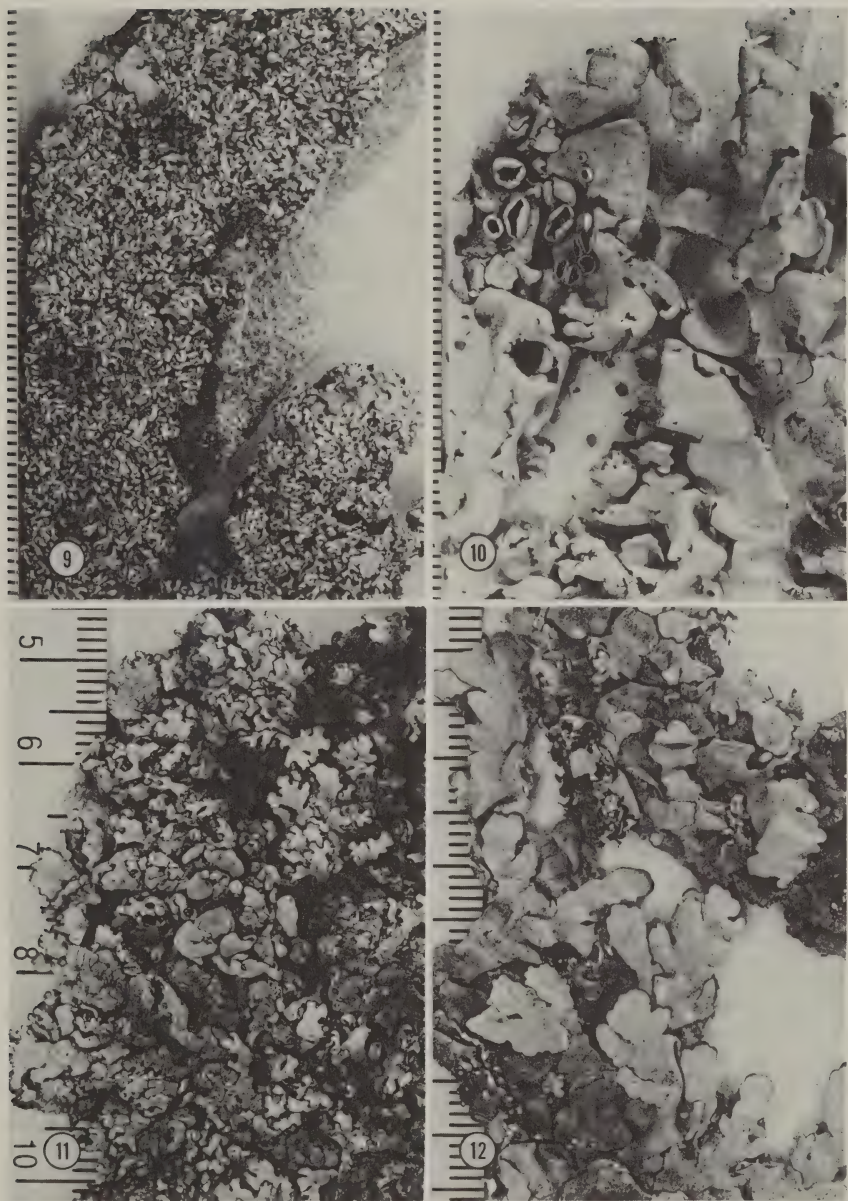
Thallus adnate to loosely adnate, nearly pulvinate, 7–10 cm broad, dull yellowish green; lobes sublinear, 0.5–1.2 mm wide, short, dichotomously branched, imbricate, becoming densely lacinate, laciniae 0.3–0.5 mm wide; upper surface continuous, shiny, emaculate, rugulose with age; isidia and soredia lacking; medulla dull reddish orange in older parts; lower surface plane, shiny, black, sparsely rhizinate, the rhizines coarse, black, 0.2–0.4 mm long.

Pycnidia and apothecia lacking.

Chemistry: Constipatic, protoconstipatic, two other fatty acids, "schenckiana" pigment, usnic acid.

Type collection: On sandstone outcrops on hillside, trail to Pillar Caves in the Drakensberg Garden area, elev. 2000 m, Natal, S. Africa, Grid 2929 CC, M. E. Hale 76668, 4 Oct. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

No other species with constipatic acid have such narrow sublinear lobes or the unidentified anthraquinone which I have called the "schenckiana" unknown, first found in *X. schenckiana* (Müll. Arg.) Hale.



Figures 9-12. Holotypes of *Xanthoparmelia*: 9, *X. laciniata*; 10, *X. latilobata*; 11, *X. laxchalybaeizans*; 12, *X. natalensis*. Scale in mm.

Xanthoparmelia latilobata Hale, sp. nov.

Fig. 10

Thallus adnatus vel laxe adnatus, saxicola vel terricola, firmus, 6–10 cm latus, lobis sublinearibus, apice rotundatis, 3–8 mm latis, contiguus, superne emaculatus, isidiis sorediisque destitutus, subtus planus, nigricans, sparse rhizinosus.

Thallus adnate to loosely adnate on soil and rock, firm and leathery, 6–10 cm broad, bright yellow green; lobes subirregular to broadly sublinear, apically rotund, 3–8 mm wide, contiguous to imbricate; upper surface continuous, shiny, emaculate; isidia and soredia lacking; lower surface plane, dull, dark brown in a broad zone at the tips but blackening at the center, finely rugulose, variably rhizinate, sparse to dense, the rhizines coarse, simple, black, 1–2 mm long.

Pycnidia present but conidia not developed. Apothecia abundantly produced, substipitate, 2–5 mm in diameter; hymenium 55–50 μm ; spores 6–7 $\times$ 12–13 μm .

Chemistry: Salazinic, consalazinic and usnic acids.

Type collection: On cave sandstone ledges in pasture, 4.1 km NE of Dordrecht, elev. 1700 m, Cape Province, S. Africa, Grid 3127 AC, M. E. Hale 73202, 9 Feb. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimens examined. S. Africa. Orange Free State: 6 km S of junction of R64 and R26 (on R64 to Maseru), S of Ladybrand, Grid 2927 AB, *Hale* 78890 (US); 4.3 km W of junction of R64 and R26 (on R26), S. of Ladybrand, Grid 2927 AB, *Hale* 74163 (US).

This species of the Cave Sandstone formation is distinguished by the broad, bright yellow green lobes. It could be allied to *X. tasmanica* (Hook. & Tayl.) Hale, which has narrow sublinear lobes 2–5 mm wide. Except for a brown lower surface, *X. crassilobata* Hale, primarily a soil lichen, is very close in lobe configuration.

Xanthoparmelia laxchalybaeizans Hale, sp. nov.

Fig. 11

Thallus laxe adnatus, saxicola, 6–10 cm latus, firmus, lobis subirregularibus vel sublinearibus, 1–3 mm latis, imbricatis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, brunneus, modice rhizinosus.

Thallus loosely adnate on rock, rarely on soil, rather stiff and firm, 6–10 cm broad, dull yellowish green; lobes subirregular to sublinear, 1–3 mm wide, imbricate; upper surface continuous, shiny; isidia and soredia lacking; lower surface plane, pale brown, moderately to densely rhizinate, the rhizines pale brown, simple, 0.5–1 mm long.

Pycnidia well developed; conidia bifusiform, 5–6 μm . Apothecia common, substipitate, 4–8 mm in diameter; hymenium 40 μm ; spores 5–6 $\times$ 8–9 μm .

Chemistry: Salazinic and usnic acids, chalybaeizans unknown.

Type collection: On granite outcrops, Nieuwoudtville Nature Reserve off hwy R27, elev. 800 m, Cape Province, S. Africa, Grid 3119 AC, M. E. Hale 72216, 29 Jan. 1986 (US, holotype; PRE, isotype).

Chemically this widespread karoo species is related to *X. chalybaeizans* (Stein. & Zahlbr.) Hale, a tightly adnate to adnate lichen also common in the karoo of S. Africa.

Additional specimens examined. S. Africa. Cape Province: Anenouspas, W of Steinkopf on the N side of hwy R382, Grid 2917 BA, *Hale* 73198 (US); 8.4 km W of Steinkopf on the N side of hwy R382, Grid 2917 BA, *Hale* 73197 (US); 3 km NE of hwy N7 on Douse-the-Glim road, Grid 3118 BC, *Hale* 78592; 41 km NE of Vanrhynsdorp, Vanrhynspas on hwy R27, Grid 3119 AC, *Hale* 73196 (US); Nieuwoudtville Nature Reserve, Grid 3319 AC, *Hale* 72227, 72228 (US); Pakhuis Pass, ENE of Clanwilliam, Grid 3218 BB, *Hale* 72225 (US); 36.4 km S of Clanwilliam on hwy N7, Grid 3218 DD, *Hale* 72223, 72224 (US); 32.7 km ESE of Citrusdal on hwy R303, Grid 3219 CA, *Hale* 72219, 72220, 72221, 72222 (US); Bainskloof on hwy N1, Grid 3319 CA, *Hale* 72226 (US); Nuwekloof on hwy R46 E of Tulbagh, Grid 3318 BD, *Hale* 78634, 78636 (US); Karoo Botanical Garden, Worcester, Grid 3319 CC, *Hale* 74165, 74166 (US); 21 km S of Worcester on hwy R43, Grid 3319 AB, *Hale* 78229, 78251, 78252 (US); 28.3 km ENE of Touwsrivier on hwy N1, Grid 3320 AC, *Hale* 77918, 77920, 78436, 78437, 78440, 78442, 78444 (US); Ouberg Pass, NE of Montagu, Grid 3320 CA, *Hale* 78087, 78101, 78102, 78103, 78108 (US); Rooiberg Pass, 22.1 km S of Calitzdorp, Grid 3321 DB, *Hale* 77721 (US); 9.9 km S junction of road S into Seweweekspoort from Lainsburg Road, Grid 3321 AD, *Hale* 73195 (US); Meiringspoort, 18 km N of De Rust on hwy R29, Grid 3322 BC, *Hale* 73199, 73200, 73201 (US).

Xanthoparmelia natalensis Hale, sp. nov.

Fig. 12

Thallus adnatus vel laxe adnatus, saxicola, 7–10 cm latus, lobis subirregularibus, apice rotundatis, 3–6 mm latis, superne emaculatus, isidiatus, isidiis cylindricis, subtus planus, pallide brunneus, sparse rhizinosus.

Thallus adnate to loosely adnate on rock, 7–10 cm broad, dull yellowish green; lobes subirregular, 3–6 mm wide, broad and apically rotund, separate to imbricate; upper surface continuous, shiny, emaculate, becoming densely isidiate, the isidia cylindrical, in part lobulate and dorsiventral, 0.1–0.15 mm in diameter, 0.2–0.3 mm high; lower surface plane, pale brown to brown, sparsely rhizinate, the rhizines simple, brown, 0.5–1 mm long.

Pycnidia and apothecia lacking.

Chemistry: Fumarprotocetraric, succinprotocetraric, diffractaic, physodalic and usnic acids.

Type collection: On sandstone ledges at edge of gorge, E of Oribi Gorge Hotel, elev. 300 m, Natal, S. Africa, Grid 3030 CB, M. E. Hale 76846, 6 Oct. 1986 (US, holotype; PRE, isotype).

Additional specimen examined. S. Africa. Natal: Umtamvuna Nature Reserve, Grid 3130 AA, Hale 76736 (US).

This appears to be a chemotype of *X. subramigera* (Gyel.) Hale, a common lichen in the Drakensberg region with strictly cylindrical isidia, a generally paler lower surface and fumarprotocetraric and succinprotocetraric acids only. This species appears to be confined to southern Natal.

Xanthoparmelia neoreptans Hale, sp. nov.

Fig. 13

Thallus laxe adnatus, terricola, 3–6 cm latus, lobis sublinearibus, centrum versus teretibus, suberectis, 0.4–1 mm latis, superne maculatus, isidiis sorediisque destitutus, subtus canaliculatus, brunneus, modice vel dense rhizinosus.

Thallus loosely adnate to nearly free growing on soil, rather fragile but not fragmenting, 3–6 cm broad, dull yellowish green; lobes sublinear, 0.4–1 mm wide, dichotomously branched and overlapping, a few lobes toward the center becoming terete, suberect; upper surface faintly to partly strongly maculate, shiny; isidia and soredia lacking; lower surface canaliculate with a more or less conspicuous yellowish rim, pale brown to brown or (especially at the tips) blackening, moderately to densely rhizinate, the rhizines brown but blackening toward the tips, simple or furcate, 0.5–1.2 mm long.

Pycnidia lacking. Apothecia rarely developed, substipitate, 3–5 mm in diameter; spores not found.

Chemistry: Fumarprotocetraric, succinprotocetraric and usnic acids.

Type collection: on soil and bokkeveld shale in sheep pasture, 3.4 km S of Van Wyksdorp on E side of hwy R327, elev. 350 m, Cape Province, S. Africa, Grid 3321 CD, M. E. Hale 77717, 19 Oct. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimens examined. S. Africa. Cape Province: 23 km SW of Ladismith on hwy R62, Grid 3321 CA, Hale 74108 (US); 25 km SSE of Klawer on hwy N7, Grid 3118 DC, Hale 78458 (US); 3.6 km NE of hwy R62 on Kruisrivier road, Grid 3321 BB, Hale 73021 (US); 1.6 km E of junction hwy R323 and Lainsburg cutoff, W of Ladismith, Grid 3321 CA, Hale 78004, 78053 (US).

In morphology and size, *X. neoreptans* is close to *X. molliuscula* (Ach.) Hale, which contains stictic acid and has numerous, well developed terete secondary lobes. The Australian *X. reptans* (Kurok.) Elix & Johnston, also containing fumarprotocetraric acid, is a larger lichen with flat, relatively broad, dichotomously branched lobes 1–2 mm wide.

Xanthoparmelia neoweberi Hale, sp. nov.

Fig. 14

Thallus adnatus, saxicola, 5–7 cm latus, lobis subirregularibus, apice subrotundatis, 1–3 mm latis, superne emaculatus, modice isidiatus, isidiis cylindricis vel subglobosis, medulla pro parte ochracea, subtus planus, brunneus, modice rhizinosus.

Thallus adnate on rock, 5–7 cm broad, light yellow green; lobes subirregular, 1–3 mm wide, apically subrotund, contiguous to imbricate, more or less black rimmed; upper surface continuous, shiny, emaculate, moderately isidiate, the isidia cylindrical to subglobose with darkened tips, 0.15–0.2 × 0.2–0.4 mm; medulla in part ochre in the lower part; lower surface plane, brown or



Figures 13-16. Holotypes of *Xanthoparmelia*: 13, *X. neoreptans*; 14, *X. neoweberi*; 15, *X. pachyclada*; 16, *X. paradoxa*. Scale in mm.

darkening, moderately rhizinate, the rhizines simple, brown, 0.2–0.3 mm long.

Pycnidia and apothecia lacking.

Chemistry: Hypoprotocetraric, 4-O-demethylnotatic and usnic acids, skyrin.

Type collection: on sandstone outcrop in pasture, 10.5 km E of Drakensberg Garden Hotel, elev. 1700 m, Natal, S. Africa, Grid 2929 CD, M. E. Hale 76663, 4 Oct. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimen examined. S. Africa. Cape Province: 17.9 km NE of Maclear, Grid 3028 CD, Hale 76884, 76888, 76893, 76898, 76899 (US); 20 km WNW of Elliott on hwy R56, Grid 3028 DB, Hale 76918, 76919 (US). Transvaal: Cycad Trail, NW of Middelberg, Grid 2528 CB, Hale 76001, 76003, 76012, 76024, 76042, 76049 (US). Natal: Royal Natal National Park, Grid 2829 CD, Hale 73203 (US); Cathedral Peak, Indumeni Forest, Grid 2829 CC, Almborn 8932 (LD, US); Drakensberg Garden, Grid 2929 CC, Hale 76689 (US); 10 km E of Drakensberg Garden, Grid 2929 CB, Hale 76658 (US). Bushman's Nek, Grid 2929 CC, Hale 76559 (US). Transkei: Moordenaarsnek, Grid 3028 DB, Hale 76918, 76919 (US).

This species is obviously closely related to and has been confused with *X. weberi* (Hale) Hale, another isidiate species with hypoprotocetraric acid but no pigments in the eastern Drakensbergs. *Xanthoparmelia neoweberi*, however, is a smaller lichen with a more consistently brown to dark brown lower surface.

***Xanthoparmelia pachyclada* Hale, sp. nov.**

Fig. 15

Thallus laxe adnatus, saxicola, 7–9 cm latus, lobis subirregularibus, 1–3 mm latis, superne emaculatus vel vix reticulato-maculatus, isidiis sorediisque destitutus, subtus planus, dense rhizinosus.

Thallus free-growing on soil, leathery and gnarled, dispersed as separate colonies 3–5 cm broad, yellowish green; lobes sublinear, 2–5 mm wide, strongly convoluted and twisted, little branched; upper surface continuous, shiny, emaculate, heavily rugose with age; lower surface strongly convoluted, pale brown, erhizinate or very sparsely rhizinate, the rhizines brown, about 0.2 mm long.

Pycnidia and apothecia lacking.

Chemistry: hypoprotocetraric, 4-O-demethylnotatic, and usnic acids.

Type collection: On soil and pebbles in succulent karoo pasture, 38.2 km NNW of Van Rhynsdorp on E side of hwy N7, elev. 200 m, Cape Province, S. Africa, Grid 3118 BC, M. E. Hale 78858, 31 Oct. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

Additional specimens examined. S. Africa. Cape Province: 36.4 km NNW of Van Rhynsdorp, Grid 3119 AC, Hale 72215, 3 km NE of N7 on Douse-the-Glim road, Grid 3118 BC, Hale 78593 (US).

This Namaqualand knersvlakte soil lichen has the same morphology as *X. beatricea* Hale (above), leathery, little branched lobes and lack of thallus dorsiventrality, but is smaller with a different chemistry. It is chemically related to another soil lichen, *X. neocongruens* Hale, which has rather strongly convoluted lobes and contains skyrin as well as the hypoprotocetraric acid group.

***Xanthoparmelia paradoxa* Hale, sp. nov.**

Fig. 16

Thallus laxe adnatus, 7–9 cm latus, lobis sublinearibus vel subirregularibus, 1–3 mm latis, superne emaculatus, centrum versus valde rugulosus, isidiis sorediisque destitutus, subtus planus, pallide brunneus, dense rhizinosus.

Thallus adnate to loosely adnate, firm and leathery, 7–9 cm broad, deep yellow green; lobes sublinear or subirregular, the lobe tips obtuse, 1–3 mm wide, contiguous; upper surface continuous, shiny, emaculate or very faintly reticulate-maculate, becoming strongly rugulose with age; isidia and soredia lacking; lower surface plane, dull, pale brown but darkening toward the tips, densely rhizinate, the rhizines pale brown, simple, 0.5–1 mm long.

Pycnidia common; conidia bifusiform, 5–6 μ m. Apothecia abundant, adnate to substipitate, 3–15 mm in diameter, the amphithecium strongly rugose; hymenium 45 μ m; spores 6 $\times$ 9–10 μ m.

Chemistry: Fumarprotocetraric, succinprotocetraric, physodalic, hypostictic, hyposalazinic and usnic acids.

Type collection: Sloping S-facing sandstone outcrops in karoo, E side of hwy R46, 2 km NW of hwy N2 (W of Touwsrivier), elev. 900 m, Cape Province, S. Africa, Grid 3319 BD, M. E. Hale 78697, 28 Oct. 1986 (US, holotype; PRE, isotype).

The unique combination of acids sets this rare species apart. It could be confused in the field with

X. austroafricana (Stirt.) Hale, which has fumarprotocetraric and succinprotocetraric acids, but lacks the strong transverse fissuring and darker greenish color of that species.

***Xanthoparmelia perrugosa* Hale, sp. nov.**

Fig. 17

Thallus adnatus, saxicola, 6–9 cm latus, lobis subirregularibus, apice rotundatis, 2–4 mm latis, superne emaculatus, aetate bullato-rugosus, isidiis soredisque destitutus, subtus planus, brunneus, modice rhizinosus.

Thallus adnate on rock but easily removed intact when moist, leathery, 6–9 cm broad, light yellow green; lobes subirregular with rotund tips, 2–4 mm wide, contiguous, soon becoming uniformly bullate-wrinkled at the center; upper surface continuous, shiny, emaculate, transversely cracked and bullate-rugose with age; isidia and soredia lacking; lower surface plane, pale brown, moderately rhizinate, the rhizines simple, pale brown, 0.3–0.5 mm long.

Pycnidia well developed; conidia bifusiform, 4–5 μ m. Apothecia well developed, adnate, 3–7 mm in diameter with an incurved rim; hymenium 45 μ m; spores 6 $\times$ 9–10 μ m.

Chemistry: hypoprotocetraric, 4-O-demethylnotatic and usnic acids.

Type collection: On doleritic boulders along trail to the landslide, Mountain Zebra National Park, SW of Cradock, elev. 1500 m, Cape Province, S. Africa, Grid 3225 AB, M. E. Hale 77940, 14 Oct. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimens examined. S. Africa. Cape Province: Same locality as the holotype, *Hale* 77774 (US); 21 km ESE of De Rust, Grid 3322 DA, *Hale* 78019 (US); 4.9 km SE of Lainsburg, Grid 3320 BB, *Hale* 73193 (US); 12 km S of jct, N side of Seweweekspoort, Grid 3321 AD, *Hale* 73192 (US); 6 km W of Britstown, Grid 78814, *Hale* 78814 (US).

There are two similar hypoprotocetraric acid-containing species: widespread *X. subdomokosii* (Hale) Hale has smooth lobes and skyrin in the lower medulla, and *X. toninioides* Hale from Namaqualand has more adnate, convex lobes 1–2 mm wide. All specimens examined develop the strong, uniform rugosity within a few millimeters of the lobe tips.

***Xanthoparmelia protodysprosa* Hale, sp. nov.**

Fig. 18

Thallus laxe adnatus, saxicola, 3–5 cm latus, lobis sublinearibus, subadscentibus, 1–1.5 mm latis, superne effigurato-maculatus, isidiis soredisque destitutus, subtus planus, niger, sparse rhizinosus.

Thallus loosely adnate on slate, 3–5 cm broad, light yellowish green; lobes sublinear, 1–1.5 mm wide, dichotomously branched, elongate, subascending, separate to imbricate; upper surface weakly to strongly effigurate maculate, shiny, rugulose and transversely cracked with age; isidia and soredia lacking; lower surface plane, shiny, black, very sparsely rhizinate, the rhizines coarse, simple with splayed tips, 0.5–1 mm long.

Pycnidia numerous; conidia bifusiform, 5–6 μ m. Apothecia lacking.

Chemistry: Lecanoric and usnic acids.

Type collection: On low shale outcrops in sheep pasture, 3.4 km S of Van Wyksdorp on hwy R327, elev. 250 m, Cape Province, S. Africa, Grid 3321 DD, M. E. Hale 77712, 19 Oct. 1986 (US, holotype; LD, PRE, isotypes).

This is a unique chemistry for the *X. hypoleia* (Nyl.) Hale complex. However, the upper surface is not as strongly effigurate maculate as other members of this complex and the thallus is rather soft, not at all stiff.

***Xanthoparmelia proximata* Hale, sp. nov.**

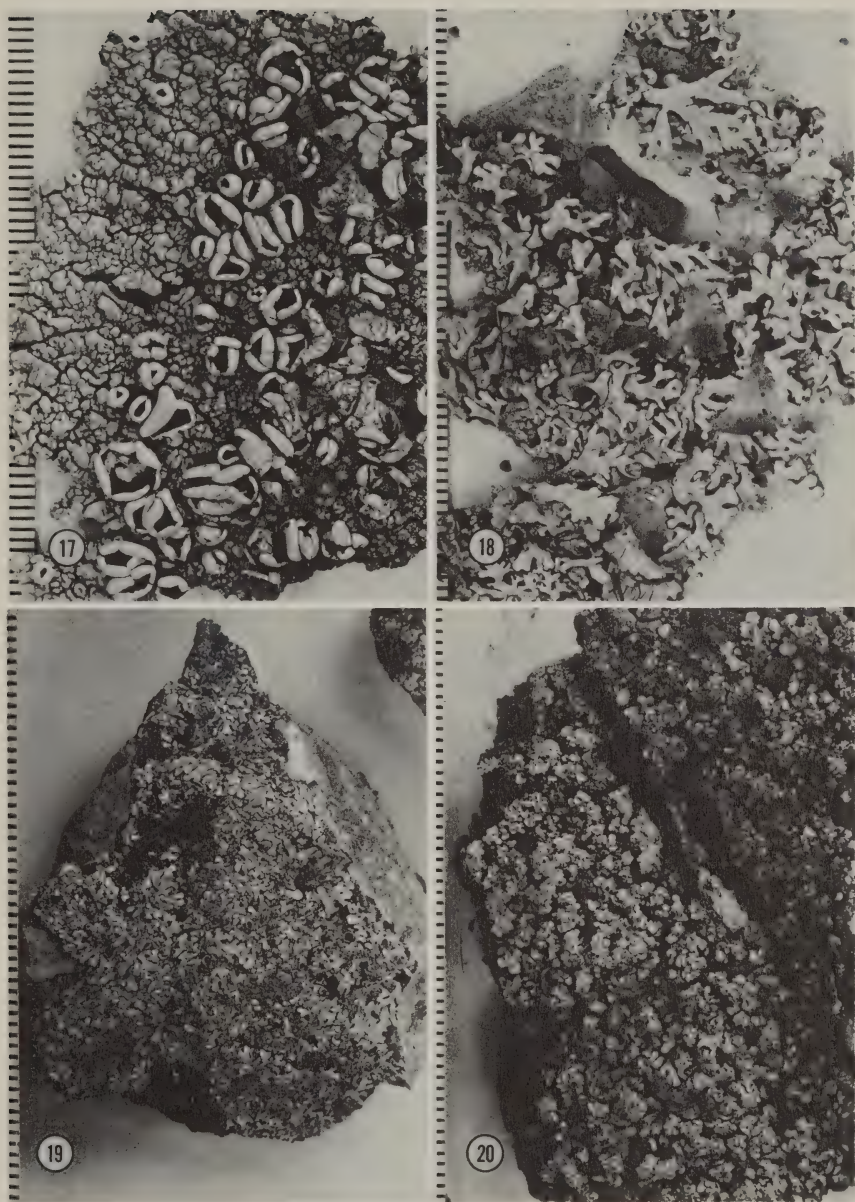
Fig. 19

Thallus arcte adnatus, saxicola, 5–7 cm latus, lobis sublinearibus, 0.5–1 mm latis, nigromarginatis, superne emaculatus, isidiis soredisque destitutus, subtus planus, niger, modice rhizinosus.

Thallus tightly adnate on rock, 5–7 cm broad, dull yellowish green; lobes sublinear, 0.5–1 mm wide, short and imbricate, dichotomously branched, black rimmed; upper surface continuous, shiny, emaculate; isidia and soredia lacking; lower surface plane, shiny, black, moderately rhizinate, the rhizines black, simple, 0.2–0.5 mm long.

Pycnidia commonly developed; conidia bifusiform, 5–6 μ m. Apothecia well developed, adnate, 1–1.5 mm in diameter; hymenium 45 μ m; spores 6–7 $\times$ 10–12 μ m.

Chemistry: Norstictic and salazinic acids in equal concentration, usnic acid.



Figures 17-20. Holotypes of *Xanthoparmelia*: 17, *X. perrugosa*; 18, *X. protodysprosa*; 19, *X. proximata*; 20, *X. rubropustulata*. Scale in mm.

Type collection: Outcrops in hillside coppie, on east side of hwy R40 at the Saddle, SE of Barberton, elev. 1500 m, Transvaal, S. Africa, Grid 2531 BC, M. E. Hale 76052, 20 Sept. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

This chemistry is relatively rare in S. African *Xanthoparmelia*. One species, *X. olifantensis* Hale, is also tightly adnate but has smaller, separate lobes 0.4–0.6 mm wide. Another, *X. minuta* Hale, Nash & Elix, is isidiate and may be a putative morphotype of *X. proximata*, except that the thallus of *X. proximata* is more robust and brighter yellow.

***Xanthoparmelia rubropustulata* Hale, sp. nov.**

Fig. 20

Thallus adnatus, saxicola, fragilis, 4–7 cm latus, lobis subirregularibus, 1–1.5 mm latis, upper surface continuous, rugosus, isidiatus, isidiis globoso-pustulatis, medulla uniforme vino-rubescens, subtus planus, brunneus, modice rhizinosus.

Thallus adnate on rock, fragile, 4–7 cm broad, dull yellowish green; lobes subirregular, 1–1.5 mm wide, contiguous and becoming crowded at the center, upper surface continuous, shiny, emaculate, rugose with age, moderately isidiate, the isidia globose-pustulate, fragile, breaking open at maturity, 0.1–0.2 in diameter, expanding to 0.5 mm and bursting; medulla uniformly deep wine red; lower surface plane, pale brown to brown, moderately rhizinate, the rhizines pale brown, simple, 0.2–0.4 mm long.

Pycnidia and apothecia lacking.

Chemistry: Salazinic and usnic acids, two "endomiltoides" anthraquinone pigments.

Type collection: On sandstone outcrops in pasture, W side of hwy R43, 17.4 km N of N2, elev. 500 m, Cape Province, S. Africa, Grid 3419 CA, M. E. Hale 78194, 26 Oct. 1986 (US, holotype; LD, PRE, isotypes).

The coarse, globose isidial growths separate this rare species from *X. endomiltoides* (Nyl.) Hale, its closest relative.

***Xanthoparmelia subpallida* Hale, sp. nov.**

Fig. 21

Thallus arctissime adnatus, saxicola, 3–8 cm latus, lobis sublinearibus, 0.3–0.8 mm latis, superne continuus, modice isidiatis, isidiis cylindricis vel globosis, subtus planus, pallide brunneus, modice rhizinosus.

Thallus very tightly adnate on rock, 3–8 cm broad, dull yellowish green; lobes sublinear, 0.3–0.8 mm wide, little branched, 2–3 mm long, separate to imbricate; upper surface continuous, shiny, emaculate, moderately isidiate, the isidia cylindrical at first, 0.1–0.2 mm wide and to 0.3 mm high, at maturity becoming globose, rarely bursting open; lower surface plane, pale brown, sparsely to moderately rhizinate, the rhizines pale, simple, ca 0.1 mm long.

Pycnidia and apothecia lacking.

Chemistry: Stictic, constictic, norstictic and usnic acids.

Type collection: On exposed ledges in grassy veld, Robinson Pass (N of Mosselbaai), elev. 800 m, Cape Province, S. Africa, Grid 3322 CD, M. E. Hale 77588, 19 Oct. 1986 (US, holotype; LD, PRE, isotypes).

The only close relative is *X. plittii* (Gyel.) Hale, which has cylindrical isidia and much wider lobes, 1–2 mm wide. Except for the predominantly globose isidia, *X. subpallida* would be considered as the subcrustose or tightly adnate member of this stictic acid-containing complex.

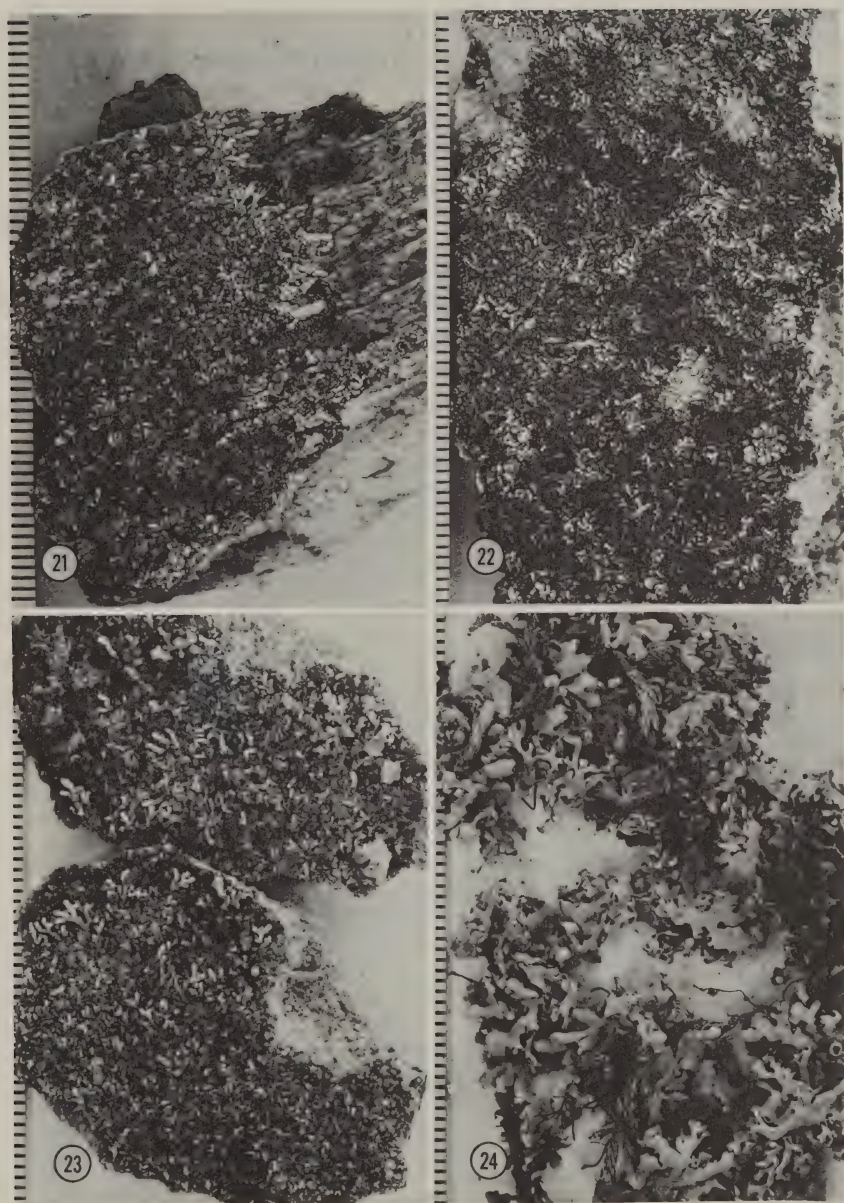
Additional specimens examined. Same locality as the holotype, Hale 77587, 77598 (US).

***Xanthoparmelia swartbergensis* Hale, sp. nov.**

Fig. 22

Thallus arctissime adnatus, saxicola, 5–10 cm latus, centrum versus areolatus, lobis sublinearibus, 0.3–1 mm latis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, niger, sparse rhizinosus.

Thallus very tightly adnate on rock, areolate at the center, 5–10 cm brown, dark yellowish green and darkening with age; lobes sublinear, 0.3–1 mm wide, rather elongate, sparingly dichotomously branched, 1–2 mm long, black rimmed, lacinate toward the center, the laciniae 0.1–0.2 mm wide; upper surface continuous, shiny, emaculate to faintly maculate; isidia and soredia lacking; lower surface plane, shiny, black, sparsely to moderately rhizinate, the rhizines black, simple, 0.2–0.3 mm long.



Figures 21-24. Holotypes of *Xanthoparmelia*: 21, *X. subpallida*; 22, *X. swartbergensis*; 23, *X. umtamvuna*; 24, *X. vendensis*. Scale in mm.

Pycnidia and apothecia lacking.

Chemistry: Fumarprotocetraric and usnic acids.

Type collection: On exposed sandstone ledges, Swartberg Pass, east side of road, elev. 1600 m, Cape Province, S. Africa, Grid 3322 AC, M. E. Hale 77623, 20 Oct. 1986 (US, holotype; ANUC, PRE, isotypes).

This species is similar to other nonisidiate tightly adnate species such as *X. adhaerens* (Nyl.) Hale and *X. conspersula* (Nyl.) Hale except for the unusual chemistry. It has been found only at high elevation in the Swartberg Mountains.

***Xanthoparmelia umtamvuna* Hale, sp. nov.**

Fig. 23

Thallus arcte adnatus, 5–7 cm latus, lobis sublinearibus, 0.3–0.6 mm latis, superne continuus. nitidus, modice isidiatus, isidiis globosis, eruptentibus aetate, subtus planus, brunneus, sparse rhizinosus

Thallus very tightly adnate, 5–7 cm broad, dull yellowish green; lobes sublinear, 0.3–0.6 mm wide, separate, dichotomously branched; upper surface continuous, shiny, moderately isidiate, the isidia globose, more or less bursting at maturity, 0.1–0.3 mm in diameter, 0.1–0.3 mm high; lower surface plane, brown, sparsely to moderately rhizinate, the rhizines brown, simple, 0.2–0.3 mm long.

Pycnidia and apothecia lacking.

Chemistry: Stictic, constictic, diffractaic and usnic acids.

Type collection: On sandstone outcrops on grassy slope, Umtamvuna Nature Reserve, elev. ca 200 m, Natal, S. Africa, Grid 3130 AA, M. E. Hale 76731, 6 Oct. 1986 (US, holotype; ANUC, LD, PRE, isotypes).

This lowland species appears to be unique in the genus. Although *X. indumenica* Hale, known from two localities in the Drakensberg foothills, has the same chemistry, it is a larger lichen with cylindrical isidia and a black lower surface.

***Xanthoparmelia vendensis* Hale, sp. nov.**

Fig. 24

Thallus laxe adnatus, terricola, 4–6 cm latus, lobis sublinearibus, apice laciniatis, 1.5–3 mm latis, superne emaculatus, isidiis sorediisque destitutus, subtus planus, pallide brunneus, sparse rhizinosus.

Thallus loosely adnate to nearly free growing on sandy soil, 4–6 cm broad but coalescing into large colonies, rather fragile, light yellow green; lobes sublinear, 1.5–3 mm wide, irregularly branched and divided apically into narrow elongate laciniae, 0.2–0.4 mm wide; upper surface continuous, shiny; isidia and soredia lacking; lower surface plane, shiny, pale brown, sparsely rhizinate, the rhizines brown, simple, 0.5–1 mm long.

Pycnidia numerous; conidia not developed. Apothecia numerous, adnate, 1–4 mm in diameter; hymenium ca 40 µm; spores 5–6 × 9–10 µm.

Chemistry: Fumarprotocetraric, succinprotocetraric and usnic acids.

Type collection: On sandy soil in *Androstachys* shrub veld, Tshikadeni Mine site, SSE of Masisi, elev. 500 m, Venda, S. Africa, Grid 2231 CB, M. E. Hale 79138, 13 Nov. 1986 (US, holotype; LD, PRE, isotypes).

Additional specimens examined. S. Africa: Venda: Same locality as the holotype, Hale 79136, 79137, 79141, 79142, 79143 (US).

The only other terricolous species with fumarprotocetraric acid, *X. acrita* Knox & Hale, has a firmer thallus and weakly convoluted lobes. *Xanthoparmelia phaeophana* (Stirt.) Hale, which does not usually grow on soil, is also much firmer and has a maculate upper surface. *Xanthoparmelia vendensis* is probably confined to sandy soils in the distinctive *Androstachys* veld community of Venda and northern Transvaal.

THREE NEW SPECIES, AND THE HISTOCHEMICAL DELIMITATION OF
GENERA IN THE GLASSY-HAIRED HYALOSCYPHACEAE

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ABSTRACT

Three new species of glassy-haired Hyaloscyphaceae are described. The problems of generic delimitations posed in trying to accommodate them are discussed. *Hyalopeziza digitipila* Huhtinen is a leaf-inhabiting species characterized by hairs with numerous basal protuberances. *Urceolella amphipila* Huhtinen is based on an old North American collection on fern fronds. It produces tetrasporous asci with large ascospores and shows a rare, violet amyloid reaction in the hair walls. *Urceolella conspicua* Huhtinen is described from Karsten's collection on *Populus* leaves. It produces septate hairs with refractive walls that lose their refractiveness in KOH, an anomalous combination of characters in currently recognized genera. The reactions of hairs and excipulum in KOH, Congo red, cotton blue, Melzer's reagent and ammonium hydroxide are summarized for 21 glassy-haired species. The genus *Mollisia* Höhn. is shown to have true hairs with solidifying matter that loses its refractiveness in KOH and ammonium hydroxide. The causes of congo-philous and cyanophilous reactions in the excipulum of hyaloscyphaceous taxa are discussed. Two new combinations are proposed, based on *Trichopeziza pygmaea* Mouton and *Unguicularia equiseti* Huhtinen.

During my studies towards a monograph in the genus *Hyaloscypha* Boud. I have come across interesting, unnamed taxa. Three of them, all with glassy hair walls, are described below. The importance traditionally attributed to the various hair types in the delimitation of genera in glassy-haired Hyaloscyphaceae made the taxonomic placement of present new taxa problematic. Especially this was true concerning a new species, *Urceolella conspicua*, with hair morphology akin to *Hyalopeziza* Fuckel, but hair chemistry closer to that of an *Urceolella* Boud. emend. Korf & Kohn. Hence, a wider material of glassy-haired taxa, which has

become available during the course of my studies, was studied to enlighten the generic delimitation.

Taxonomic papers dealing with glassy-haired members of the Hyaloscyphaceae have traditionally emphasized morphological characters, e.g., hair curvature and the absence or presence of a lumen as highly justifiable criteria at the generic level. A new era was marked by the papers of Korf & Kohn (1980) and Raschle (1977), which stressed the reactions of hairs in KOH. Korf and Kohn accepted the generic name *Urceolella* for species with hairs that lose their refractiveness after exposure to KOH. Their concept of *Hyalopeziza* was very wide and the genera *Unguiculariopsis* Rehm, *Unguicularia* Höhn. and *Unguiculella* Höhn. were recognized as subgenera of *Hyalopeziza*, a genus having hairs that retain their refractiveness in KOH. The introduction of chemical properties as the basis for generic delimitation is partly in contrast to the earlier, morphological classification. Encountering the three new taxa forced me to select between these two classification strategies. As detailed below, results obtained by the use of KOH are supported by observations in Congo red and ammonium hydroxide.

In face of the new problems of classification that have come to light during this study, I have made a partial rearrangement of a few species, with accompanying new combinations. These are based on the belief that at present the chemical characters of the hairs should be stressed. The polyphyletic origin of glassy hairs cannot, however, be excluded from our taxonomic thinking. Glassy-haired taxa with equally solidified hairs or with equal chemical reactions need not necessarily be closely related. At present there is, however, no evidence supporting the splitting of these genera and species, which for very long have stood close together. A study combining morphology, histochemistry and, above all, cultural characters would be revealing in this respect.

MATERIALS AND METHODS

Microscopic examinations were made with Wild M20 research microscope with bright field and phase contrast optics and linear magnification up to X1460. Some observations were checked with Leitz Orthoplan research microscope; objective "NPL Fluotar X100", aperture 1.32. Five mountants were used:

1. Melzer's reagent: 0.5 gm iodine, 1.5 gm KI, 20 gm chloral hydrate, 20 ml distilled water. The reagent was used without KOH pretreatment, if not otherwise stated.

2. Cotton blue: 0.5 gm of cotton blue (Hollborn, Leipzig) dissolved in 99.5 ml of lactophenol (equal proportions of phenol, glycerine, lactic acid and distilled water). The material was placed in a large drop of cotton blue on a glass slide; boiled for ca. ten seconds; all the excess dye removed; a drop of lacto-

phenol added. With this procedure the contrast of the staining reaction is improved as the stained material appears blue on a colorless background.

3. Congo red: a saturated solution in concentrated (25%) ammonium hydroxide, pH 12.0. The stain was gently heated except when staining *Mollisina*, in which observations were made in unheated mounts. To improve the contrast the excess dye was removed by adding tap water.

4. Ammonium hydroxide: 25 % aqueous solution, gently heated.

5. Potassium hydroxide: 10 % aqueous solution was used, if not otherwise stated. The mounts were gently heated.

All measurements were made in cotton blue. Observations on the loss of refractiveness in the hairs of *Mollisina* spp. were made by first treating the mount with gently heated ammonium or potassium hydroxide and then staining with cotton blue. The studied material is indicated in Table 1. The drawings were made with the aid of a camera lucida.

NEW HISTOCHEMICAL CHARACTERS

In trying to logically accommodate three new taxa, which do not fit within current circumscriptions of genera, I have made a compilation of histochemical data presented in Table 1. It should be noted that a thorough revision is beyond the scope of this study. It already seems, however, that these results call for more emphasis on the chemical characters of the hairs, even though the stains and reagents used are not especially specific (Johansen 1940).

These results suggest that loss of refractiveness in KOH, which was stressed by Raschle (1977) and Korf & Kohn (1980), is coupled with the resistancy of the refractive material to ammoniacal Congo red (when intact). Two types of reactions are seen in KOH: the immediate swelling of refractive material with subsequent deformation of hairs, or a mere loss of refractiveness without drastic structural changes in hairs. The former type prevails in *Urceolella* while the latter is seen in *Mollisina* and *Unguiculella xylicola* Böhler, and may be due to smaller amounts of the reacting substance. The genus *Mollisina* is, however, characterized also by the loss of refractiveness even in gently heated ammonium hydroxide mounts, after which the hairs are permeable to Congo red.

Hairs that retain refractiveness in KOH show variation in their staining reactions: those traditionally accommodated in *Hyalopeziza* are permeable to Congo red, and those in *Unguicularia* can be either permeable or impermeable. A dextrinoid reaction is only seen in hairs retaining their refractive nature in KOH, but the presence or absence of this reaction varies even between closely related species.

An amyloid reaction is rare, and is seen in one species with unstable refractiveness.

Although the results should be considered as preliminary, they suggest that hair chemistry is a more reliable character than the presence or absence of a lumen in hairs. Both solid (or at least seemingly solid under the microscope) hairs and hairs with more or less clear lumina were encountered in single apothecia of four of the studied species. It is therefore wise to reconsider solid versus luminal hairs as a character at the generic level. Evaluating the septation of hairs is more difficult. Raschle (1977), stressing hair chemistry in his classification, has already delimited *Hyalopeziza* to include species with either septate or aseptate hairs. But could the concept of *Urceolella* as a genus uniformly with aseptate hairs be similarly broadened to include species with septate hairs, if the broader concept accommodated chemical characters more naturally? I have tentatively taken this view, partly because the idea of creating a new genus is unattractive at a stage when new glassy-haired taxa are still frequently found in nature.

My observations suggest that the substances solidifying the hairs are chemically different from those of the wall proper. Staining KOH-pretreated, deformed hairs of *Urceolella crispula* (Karst.) Boud. and *U. carestiana* (Rab.) Dennis with Congo red revealed a thin wall proper enclosing a strongly swollen, deformed substance. In *Protoungicularia brevicapitata* Raitv. & Galán a dual structure of the refractive parts is evident in Melzer's reagent; the wall proper being nondextrinoid and the solidifying matter being dextrinoid. In *Unguiculella xylemicola* the wall proper remains intact after KOH exposure while the solidifying matter is dissolved.

In many cases the excipulum of these glassy-haired taxa can be defined as being cyanophilous or congophilous. Although cotton blue never stains hair wall material, excipulum appears to be clearly stained when studied with low magnification. A closer scrutiny reveals, however, the difficulties in interpretation. In many species it is hard to make out clearly whether the wall itself is being stained or whether cyanophilous, extraneous matter occurs. In at least two hyaloscyphaceous species such a substance is occupying the narrow space between excipular cell walls that remain unstained, namely *Dasyscypha capitata* (Peck) LeGal and *Hyaloscypha reticulata* Vacek. The latter, which has exceptionally large excipular cells, belongs to an undescribed hyaloscyphaceous genus. In the holotype (in PRM) this extraneous substance is easily seen. It is probable that such a substance characterizes the excipula in many genera and species. As in the two cases mentioned above, a positive reaction is always characterized by a high affinity for the dye, resulting in stronger staining than observed in, e.g., hymenial elements. Therefore, rather than suggesting chemical differences between hair and excipular walls, the compilation in Table 1. indicates the presence versus absence of this extraneous substance.

Table 1. The response of hairs and excipulum to chemical reagents in species of glassy-haired Hyaloscyphaceae.
 + = staining or losing refractiveness / lumen or septa present
 - = no reaction / no septa or lumen
 IKI = Melzer's reagent

	H A I R S				E X C I P U L U M				Type; Arendholz, pers.comm
	Lumen	septa	Congo red		KOH	Congo red		IKI	
			-	+		-	+		
<i>Hyalopeziza ciliata</i>	+	+	-	+	-	n	d	a	TUR 75128
<i>H. valesiaca</i>	+	+	-	+	-	-	-	-	Type, S
<i>H. nectriotidea</i>	+	+	-	+	+	+	-	-	TUR 78745
<i>H. corticicola</i>	+	+	-	+	-	+	+	-	Type, TUR
<i>H. digitipila</i>	±	-	-	+	-	+	+	-	Type, BR
<i>Trichopeziza pygmaea</i>	±	-	-	+	-	-	-	-	TUR 82304
<i>Unguicularia raripila</i>	+	-	-	-	-	-	-	-	TUR 73241
<i>U. millepunctata</i>	-	-	-	-	-	-	-	-	MPU, Maire 6775
<i>"Hyalosecypha albobinosa"</i>	-	-	-	-	-	-	-	-	TUR 62868
<i>Unguicullella eurotioides</i>	-	-	-	+	-	-	-	±	Type, Herb. Galán
<i>Protounguicularia brevicapitata</i>	-	+	-	+	+	-	-	-	TUR 78785
<i>Ureoelella hamulata</i>	-	-	+	-	+	+	+	-	Type, H
<i>U. conspiciua</i>	+	+	+	-	+	+	+	-	TUR 71068, 67463
<i>U. carestiana</i>	+	+	+	-	+	+	+	-	TUR 75559
<i>U. crispula</i>	+	+	+	-	+	+	+	-	Type, F
<i>U. amphipila</i>	±	-	+	-	+	+	+	-	Type, TUR
<i>Unguicularia equiseti</i>	-	-	+	-	-	+	+	-	Type, OSLO
<i>Unguicullella xylemicola</i>	±	-	+	-	-	+	+	-	NY, Seaver & Bethel 1910
<i>Mollisia flava</i>	-	-	+	-	-	+	+	-	Jaap Fungi Sel. Exs. 360
<i>M. rubi</i>	-	-	+	-	-	+	+	-	Krieger Fungi Sax. 881, NY
<i>M. acerina</i>	-	-	+	-	-	+	+	-	

Table 1 indicates that the present histochemical approach and the classification based on hair morphology are partly in conflict. Uniformity in morphology, chemical characters and in ecology is seen in *Mollisia*, which is a probable monophyletic unit. Until more is done to determine the nature of the substances involved in hair solidification, the ultimate advantages of histochemistry will remain unsettled. Already, histochemistry seems to stand scrutiny in generic delimitations, especially when compared to the use of solid versus luminal hairs as characters at the generic level. Presently I am working with the interactions of single-spore isolates in *Hyaloscypha* and its closest allies, and knowledge of such interactions and other cultural characters may turn out to be a very valuable taxonomic tool in generic delimitation.

NEW TAXA

Hyalopeziza digitipila Huhtinen, sp.nov.

-Fig. 1.

Apothecia initio cupulata, deinde convexo-planiuscula, breviter stipitata, minuter pilosa; specimina exsiccata usque ad 250 µm lata, nivea praeter basin stipitum, quae est pallide brunnea. Excipulum externum textura prismatica, cellulis 6-12 X 4-7 µm vel 14-16 X 6-8 µm, hyalinis, aliquantum crassotunicatis, in iodo non colorantibus. Pili usque ad 45 µm longi, hyalini, in iodo non colorantes, basaliter 2-3 µm lati, acuminati, leves, valde crassotunicati sed lumen continuum habentes; typice in basali parte diverticula angustata, solida, usque ad 10 µm longa habentes. Asci 42-48 X 6-8 µm, octospori, leviter amyloidei. Sporae irregulariter uniseriatae, ellipsoideae, 7-10 X 3-4 µm, non septatae, rectae, hyalinae, leviter guttulae. Paraphyses claviformes, in apicali parte 3 µm latae, cellulis terminalis 16-22 µm longae, infra apicem arte septatae, 2 µm latae.

Holotype: Canada, N.W.T., MacKenzie District, Inuvik, grid 5428, on leaves of *Alnus crispa* (Ait.) Pursh, 18.IX. 1984 Huhtinen 84/185 (TUR 81699); isotype in DAOM.

Paratypes: Inuvik, close to the research station, on *Alnus* leaves, 14.IX.1984 Huhtinen 84/163 (TUR 81697); by the gravel pits, grid 5428, on *Alnus* leaves, 16.IX.1984 Huhtinen 84/180a (TUR 81696).

Apothecia gregarious, first cupulate with a flat disc and short stipe, later discoid and margin not raised, texture soft and spongy, apothecia up to 250 µm in diameter when dried, pure white except for the stipe base fringed with brown tissue, more rarely dried apothecia brownish.

Ectal excipulum of textura prismatica, cells varying in size from 6-12 X 4-7 µm to 14-16 X 6-8 µm, walls hyaline, up to 0.8 µm thick, refractive, J- with and without KOH pretreatment but appearing to be stained in cotton blue and Congo red.

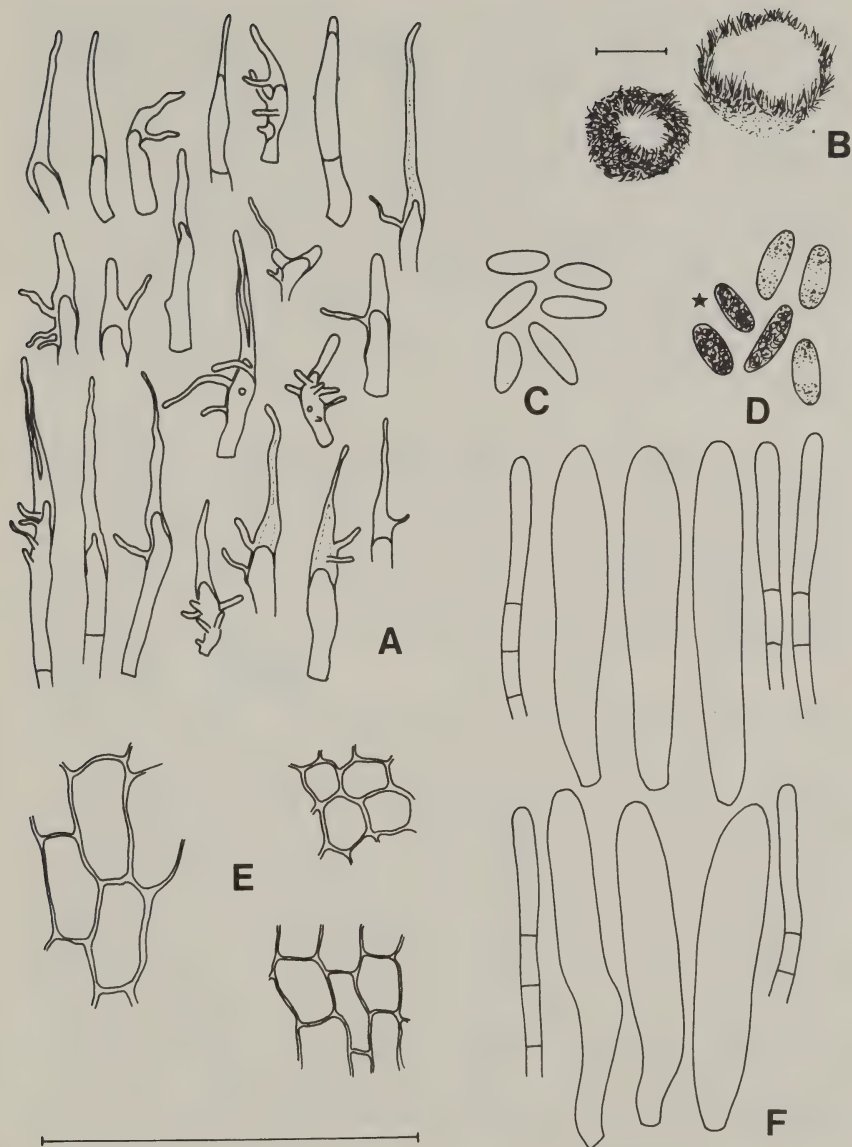


Fig. 1. Holotype of *Hyalopeziza digitipila*, scale 50 μm , for apothecia 100 μm , in cotton blue if not otherwise stated. --A. hairs--B. dried apothecia--C. spores--D. spores in water and in KOH (marked)--E. ectal excipulum from different parts of apothecia --F. asci and paraphyses.

Hairs up to 45 μm long, 2-3 μm broad at bases, tapering to often less than 1 μm broad at apices, hyaline, typically with numerous basal, narrow, up to 10 μm long diverticula, which occasionally occur in the middle of the hair; hair walls basally thin, becoming very thick towards apex, often obscuring the narrow, continuous lumina, smooth, J-, not staining in cotton blue, but strongly stained in Congo red, refractiveness stable even in unheated, 40 % KOH.

Asci cylindrical, not developing from croziers, 42-48 X 6-8 μm , eight-spored, porechannel wall faintly amyloid without KOH pretreatment, deep blue after pretreatment, walls not stained in Congo red. Ascospores irregularly uniseriate, ellipsoid, 7-10 X 3-4 μm , aseptate, smooth, indistinctly guttulate in cotton blue, contents spumose in KOH. Paraphyses somewhat clavate, 2 μm broad and closely septate below, apex 3 μm broad, terminal cells 16-22 μm long, not exceeding the asci.

This leaf-inhabiting species was found to be common in the vicinity of Inuvik, and was often growing together with *Hyaloscypha lachnobrachya* (Desm.) Nannf. Though the hairs may appear to be totally solid, a continuous lumen is very often seen in cotton blue mounts; not rarely the lumen becomes wider at hair apices, as happens in many species of *Urceolella*. The chemical features of hairs, however, suggest a more appropriate placement in *Hyalopeziza*. The solid protuberances occur only on hairs, marking a major distinction to *Mollisia* (see below).

Urceolella amphipila Huhtinen, sp. nov.

-Fig. 2.

Apothecia cupulata, sessilia vel basaliter constricta, minuter pilosa; specimina exsiccata usque ad 200 μm lata, ochracea vel brunnea, margo involutus. Excipulum externum textura prismatica, cellulis 10-13 X 3-5 μm prope marginem, alibi usque ad 17-20 X 6-8(-10) μm , tenuiter tunicatis vel aliquantum crassotunicatis, pallide brunneis, in iodo non colorantibus. Pili usque ad 55 μm longi, 2-3 μm lati, aliquantum angustati, leves, amyloidei, valde crassotunicati sed lumen continuum habentes; brevissimi pili bifformes, cylindrati vel ramosi, tenuiter tunicati, in iodo non colorantes, 13-18 X 2-4 μm , leves. Asci late cylindrati, pro parte majore tetraspori, raro octospori, 40-53 X 8-11 μm , clare amyloidei, basi minuter bifurcati, apice crebro papillati. Sporae oblongo-ellipsoideae vel subfusiformae, minuter curvatae, 20-26 X 3-4 μm , non septatae, leves, corpuscula refractiva habentes. Paraphyses filiformes, 1-2 μm latae, cellulis terminalibus 30-37 μm longis.

Holotype: U.S.A., Vermont, Shelburne, on stalks of *Struthiopteris*, 15.V.1880 Pringle 1033 (F), sub *Trichopeziza osmundae*.

Apothecia gregarious, cupulate with an inrolled margin, sessile or base somewhat narrowed, texture not especially soft, apothecia up to 200 μm in diameter when dried, flanks

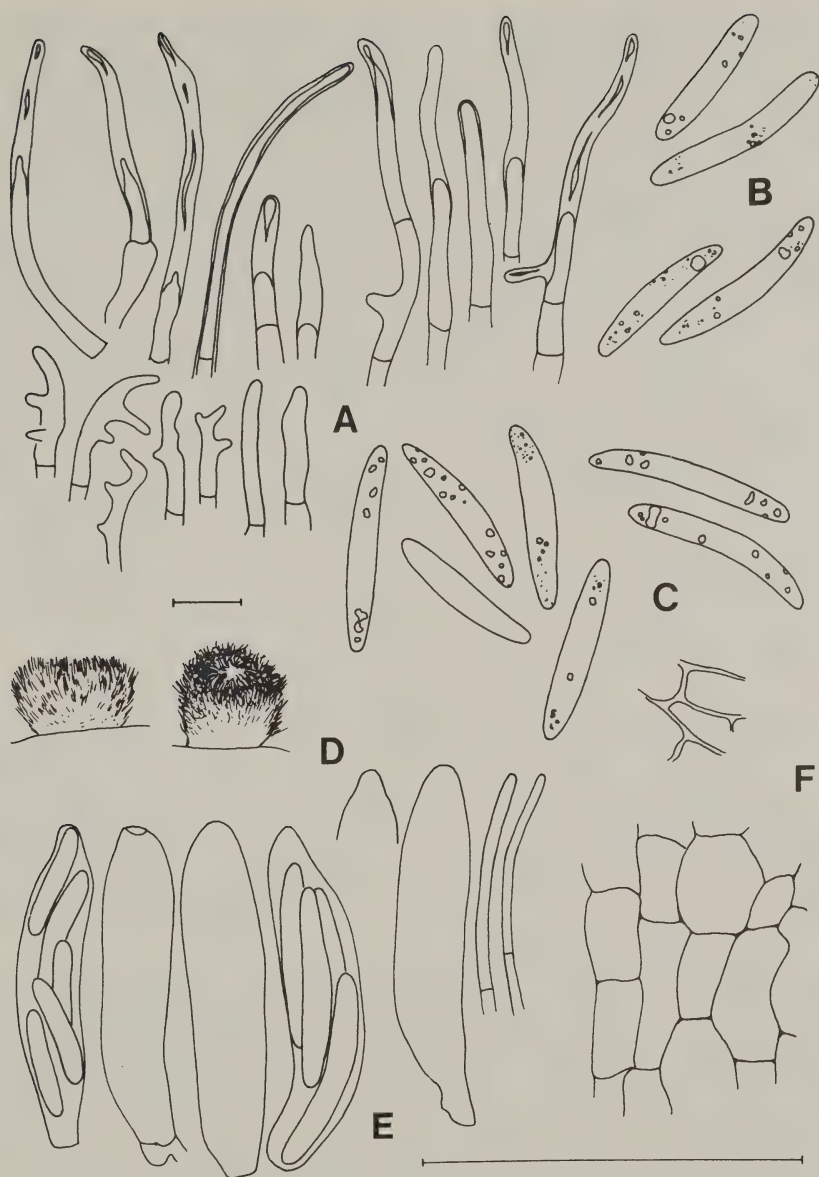


Fig. 2. Holotype of *Urceolella amphipila*, scale 50 μ m, for apothecia 100 μ m, in cotton blue if not otherwise stated. --A. hairs--B. spores in Melzer's reagent--C. spores--D. dried apothecia --E. asci and paraphyses--F. ectal excipulum, showing the total variation in wall thickness.

ochraceous to brownish, color modified by a dense covering of hyaline hairs.

Ectal excipulum of textura prismatica, cells 10-13 X 3-5 μm close to margin, 17-20 X 6-8(-10) μm below, walls light brownish, mostly thin, more rarely thickened (up to 0.5 μm), J- with and without KOH pretreatment but appearing to be stained in cotton blue and Congo red.

Hairs up to 55 μm long, 2-3 μm broad, straight to somewhat bent, somewhat tapering, typically unbranched, very rarely with one basal protuberance; hair walls basally thin but becoming very thick towards apex, showing a continuous lumen, which is only at places obscured and is typically widened at the apex, smooth, J+ with a violaceous tinge, not staining in cotton blue or Congo red, structure stable in unheated 3 % KOH but refractiveness lost immediately in 4 %, unheated KOH; at the margin two types of small hairs present, equally common, one measuring 13-18 X 2-4 μm , cylindrical, thin-walled, J-; the other type similar but with clear protuberances on one side.

Asci broadly cylindrical, developing from croziers, 40-53 X 8-11 μm , typically four-spored, rarely eight-spored, porechannel wall clearly amyloid even without KOH pretreatment, refractive in KOH, walls thin throughout, not stained in Congo red. Ascospores oblong-ellipsoid to subfusoid, typically somewhat curved, 20-26 X 3-4 μm , aseptate, smooth and in cotton blue regularly with 1.5 μm broad or smaller, angular, refractive bodies. Paraphyses filiform, 1-2 μm broad, terminal cells 30-37 μm , not exceeding the asci.

The species is easily recognized under the microscope by the amyloid reaction of hairs and the large ascospores. The obvious violet reaction in hair wall material is a very rare character in *Hyaloscyphaceae*. So far I have noted it in two species of the recent genus *Protounguicularia* Raitv. & Galán, and an identical reaction is very rarely found in the hairs of *Hyaloscypha stevensonii* (Berk. & Br.) Nannf. In these three cases the amyloid reaction is very strong resulting in a blackish violet color. They will be discussed in forthcoming treatises of the genus *Protounguicularia* (Huhtinen 1987 and in ms.).

From the results I have so far obtained in *Hyaloscypha* and its allied genera it seems that the resulting color of hairs in Melzer's reagent is a more important character at the generic level than the mere presence or absence of a positive reaction. For example in *Hyaloscypha* the resulting color is purplish red, but in *Hyalopeziza corticicola* (Dennis) Raitv. and *H. nectrioides* (Rehm) Raschle it is clearly more brownish.

The presence of thin-walled, small hairs at the margin is typical of many species with glassy hairs (cf. Raschle 1977, Huhtinen 1985b). In many cases these are nothing but juvenile hairs where the secondary wall material has not yet started to accumulate. But in addition to such hairs, *U. amphipila* also has small and branched marginal hairs that apparently do not become thick-walled.

Pringle's collection on stalks of *Struthiopteris*

(= *Matteuccia* Tod.) is a very ample one, bearing hundreds of apothecia. His determination to *Trichopeziza osmundae* (Cooke & Ellis) Sacc. is erroneous; compare for example Fig. 2. with the illustration by Dennis (1963: 357).

Urceolella conspicua Huhtinen, sp. nov.

-Fig. 3.

Apothecia cupulata, breviter stipitata, usque ad 1.5 mm in diametro; specimina exsiccata usque ad 1.2 mm in diametro, ochracea vel brunnea, margo albopilosus. Excipulum externum textura prismatica vel textura angulari, cellulis 11-18(-28) X 4-8 μ m prope marginem, 7-10 X 2-4 μ m in basi, hyalinis, aliquantum crassotunicatis, in iodo non colorantibus. Pili usque ad 330 μ m longi, in basi 4-6 μ m lati, recti, cylindrati, aliquantum angustati, obtusi, leves, in iodo non colorantes; in basi tenuiter tunicati, sursum crassotunicati vel valde crassotunicati sed lumen septatum habentes. Asci 65-90 X 8-10 μ m, octospori, amyloidei. Sporae ellipsoideae, 10-20 X 3-5 μ m, hyalinae, uniseptatae, minuter guttulate. Paraphyses cylindratae, 2-3 μ m latae, cellulis terminalibus 30-40 μ m longis.

Holotype: Finland, Etelä-Häme, Tammela, Mustiala, on needles of *Juniperus* and leaves of *Populus*, 22.X.1866 Karsten (H, Herb. Karsten 2627), sub *Peziza papillaris*.

Apothecia solitary or in small groups, cupulate with a short and firm stipe, texture not especially soft, apothecia up to 1.5 mm in diameter when fresh, up to 1.2 mm when dried, whitish when fresh, flanks and disc ochraceous to brownish when dried, margin whitish due to a dense cover of hyaline hairs.

Ectal excipulum of textura prismatica, changing to textura angularis at stipe base, cells 11-18(-28) X 4-8 μ m close to the margin, 7-10 X 2-4 μ m at stipe base, walls hyaline, somewhat thickened (0.5-0.8 μ m), J- with and without KOH pretreatment, appearing to be stained in cotton blue and Congo red.

Hairs up to 330 μ m long, 4-6 μ m wide at bases, often tapering to 3-4 μ m broad at the blunt apices, hyaline, straight, multiseptate with thin septa, more rarely aseptate; hair walls basally thin, typically becoming very thick towards apex and sometimes partly obscuring the lumina, smooth, J-, not staining in cotton blue or Congo red, wall material dissolved and refractiveness lost already in 5 %, unheated KOH, but the last septal intervals burst rapidly only when 10-30 % KOH is added.

Asci cylindrical, developing from croziers, 65-90 X 8-10 μ m, eight-spored, porechannel wall clearly amyloid even without KOH pretreatment, walls not stained in Congo red. Ascospores ellipsoid, 10-20 X 3-5 μ m, often one-septate when mature but also large, aseptate spores present, spores not becoming septate in asci, minutely guttulate at each end. Paraphyses narrowly cylindrical, 2-3 μ m broad, terminal cells 30-40 μ m long, not exceeding the asci.



Fig. 3. Holotype of *Urceolella conspicua*, scale 50 μ m, for apothecia 200 μ m, in cotton blue if not otherwise stated. --A. spores in Melzer's reagent--B. spores--C. paraphyses--D. asci--E. marginal hairs--F. dried apothecia--G. ectal excipulum.

The present collection is the one Karsten (1871: 161) cited under *Helotium papillare* (Bull.) Karst. as "Forma major (apotheciis latit. 1,5 mm.) supra folia putrida Populi et Juniperi...". It is evident that he had no intention to treat the collection as a taxonomic forma. Karsten was very careful in including the infraspecific taxa in the index and in marking them in the text, which is not the case concerning the present collection. Hence, Karsten's use of the word "forma" has no nomenclatorial consequences. In contrast to his statement, I could find no apothecia on juniper needles.

The huge hairs of *U. conspicua* are usually septate, occasionally aseptate, and typically show clearly thickened walls. The shorter hairs are similar but are more frequently aseptate. This variation parallels that of *Hyalopeziza trichodea* (Phill. & Plowr.) and *H. niveocincta* (Graddon) Raschle (Raschle 1977). In addition to chemical characters of hairs it should be noted that some hairs of *U. conspicua* i.e. those that are aseptate and luminal, clearly match those traditionally accepted in *Urceolella*. Hair septation in the genus should perhaps be treated at the infrageneric level, as was done by Korf & Kohn (1980) with even a more prominent morphological character, namely the hooked and glassy apices of hairs and paraphyses of *Urceolella* subgenus *Hyalacrotis* Korf & Kohn.

ADDITIONAL SPECIES EXAMINED

Hyalopeziza pygmaea (Mouton) Huhtinen, comb.nov.

=*Trichopeziza pygmaea* Mouton, Bull. Soc. Roy. Bot. Belg. 36(2): 19. 1897.

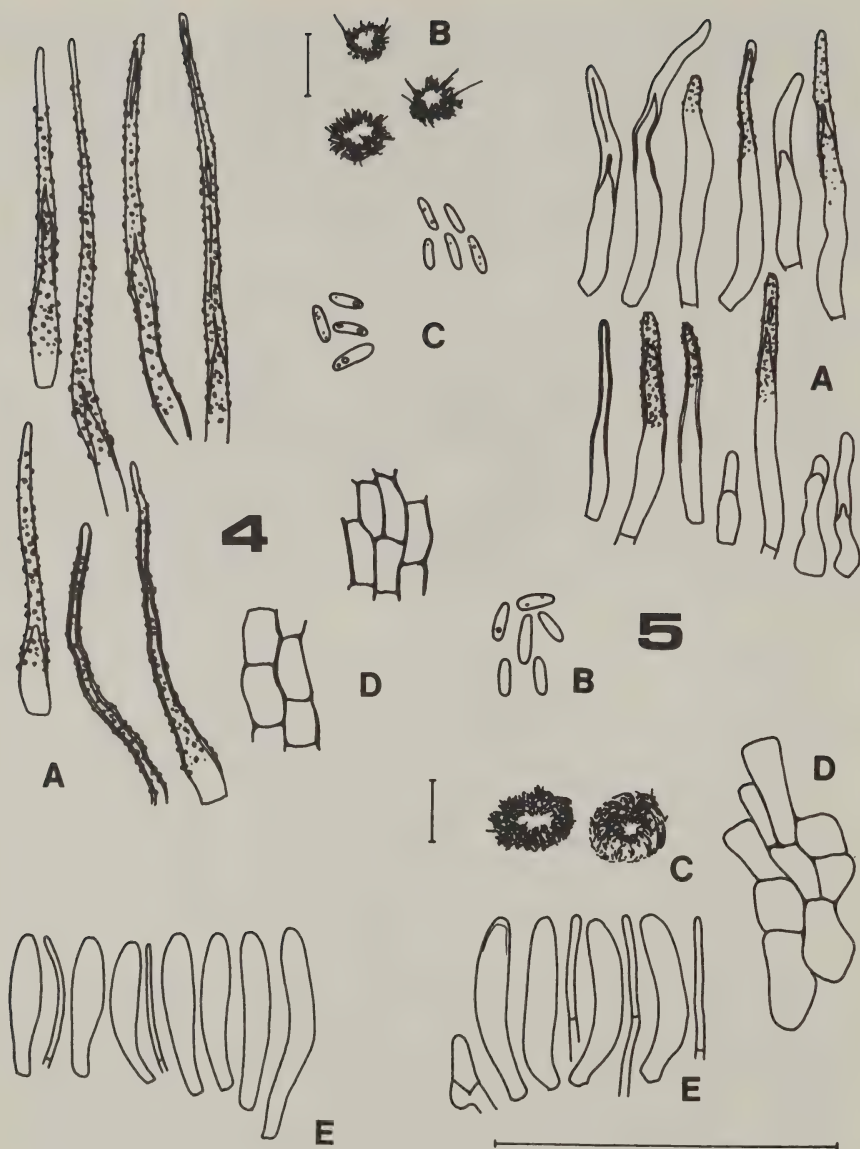
=*Hyaloscypha pygmaea* (Mouton) Boud., Hist. Classific. Discomyc. Europe, p. 127. 1907.

=*Unguicularia pygmaea* (Mouton) Svrček, Česka Mykol. 39: 217. 1985.

=*Hyaloscypha subtilis* Vel. var. *drupacea* Vel., Monogr. Discomyc. Bohem., p. 273. 1934.

As pointed out by Svrček (1985), *Trichopeziza pygmaea* is among the species where the delimitation between *Hyalopeziza* and *Unguicularia* becomes vague. As it is not the only example of such a species, I have adopted the wider concept of *Hyalopeziza* outlined by Korf & Kohn (1980) and propose a new combination.

After studying both the type of *Trichopeziza pygmaea* (in BR) and *Hyaloscypha subtilis* var. *drupacea* (in PRM) I can confirm Svrček's (1985) view of their conspecificity (Figs. 4-5). Again hairs with and without a lumen occur on each apothecium. Most hairs are superficially rough, with warts along the whole length of hairs. These warts, which are up to 1.0 µm in width and 0.8 µm in height, are strongly cyanophilous and congophilous and cannot be easily detached. But a week-old lactic acid mount showed totally smooth hairs.



Figs. 4-5. *Hyalopeziza pygmaea*, scale 50 μ m, for apothecia 100 μ m. -- Fig. 4. Type of *Trichopeziza pygmaea*.--A. hairs--B. dried apothecia--C. spores--D. excipulum--E. asci and paraphyses. -- Fig. 5. Type of *Hyaloscypha subtilis* var. *drupacea*.--A. hairs--B. spores--C. dried apothecia--D. excipulum--E. asci and paraphyses.

Due to the prominent warts, the species seems to hold an isolated position in the genus. Prominent warts are seen also in a collection from leaves of *Laurus nobilis* (I.M.I. 255787) but noteworthy variation occurs in a collection from *Pinus* cone (I.M.I. 237320). In cotton blue and Congo red mounts of this specimen the hairs are often lacking the warts, and in Melzer's reagent they are seen as strongly swollen and deformed globules, which are easily detached. The inconsistent nature of these warts is the main criterion for not suggesting a new genus based on *T. pygmaea*.

Urceolella equiseti (Huhtinen) Huhtinen, comb.nov.

= *Unguicularia equiseti* Huhtinen, Karstenia 25: 17. 1985.

When describing the species I stressed the lack of a lumen in hairs against the KOH instability of the wall material (1985a). From examples discussed above it is now evident that I must back away from my earlier opinion and treat the species under *Urceolella* subg. *Urceolella* in the sense of Korf & Kohn (1980). The KOH instability of the hairs, coupled with impermeability to Congo red and the cyanophilous and congophilous reactions of excipulum, indicates relationship to species of *Urceolella*. This species is not likely to be a *Mollisia* in the light of the re-evaluation of the genus which follows.

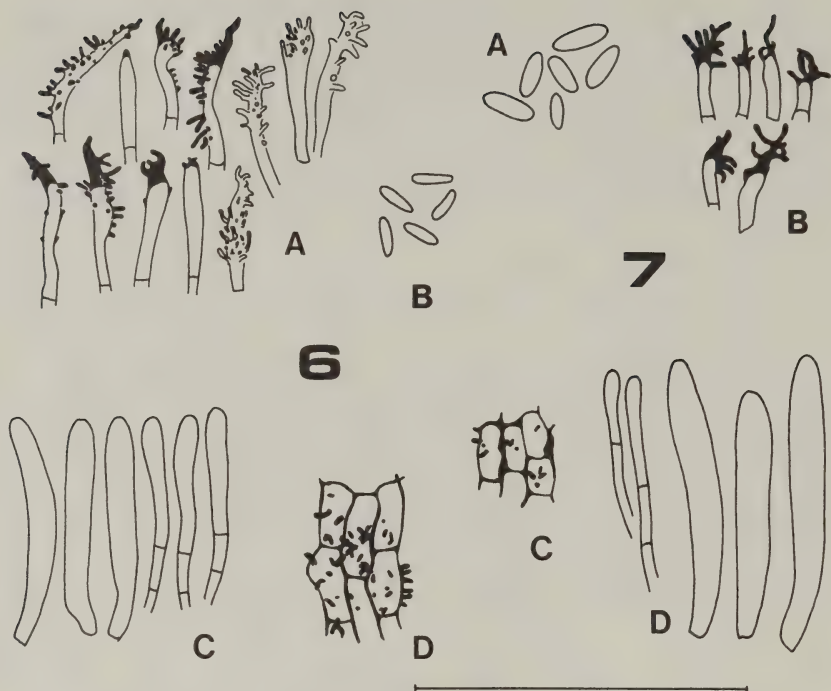
Hyaloscypha albovinosa Maire, nom.herb.

This specimen is preserved in MPU and seems to represent an unknown species of *Hyalopeziza* subg. *Unguicularia* (Höhn.) Korf & Kohn. The hair morphology is identical to that in *U. millepunctata* (Lib.) Dennis, but in "*Hyaloscypha albovinosa*" the ascospores are longer and fusoid, the asci are more blunt at their apices, and the hairs do not react in Melzer's reagent.

ON THE GENUS MOLLISINA

Since the days of von Höhnel's (1926) original diagnosis the genus *Mollisia* has been burdened by the erroneous observation that the apothecia do not bear typical glassy hairs, but only small, solid protuberances emerging from the excipular cells. In all the species that I studied, however, the margin bears true hairs, i.e. processes that differ morphologically or chemically from the other cells of the excipulum. These hairs are cylindrical to tapering with thin basal walls and wide lumina, and are ornamented with solid projections (Figs. 6-7). The brick-shaped excipular cells often bear similar solid projections, but true hairs were not observed on the lower flanks and stipes of apothecia.

The characteristic ornamented hairs are best observed in *M. flava* Arendholz (Fig. 6). This species belongs also



Figs. 6-7. Species of *Mollisina*, scale 50 μ m, in cotton blue if not otherwise stated. -- Fig. 6. *Mollisina flava*, Seaver & Bethel 3-12.IX.1910, NY.--A. hairs in cotton blue and four hairs as they appear in Melzer's reagent--B. spores--C. asci and paraphyses--D. excipulum with solid projections. -- Fig. 7. *Mollisina acerina*, Sydow, Mycoth. March. 4042, NY.--A. spores--B. hairs--C. excipulum with solid projections--D. asci and paraphyses.

to the American mycoflora, and is richly represented in one specimen from the NY herbarium (Colorado, 3-12.IX.1910 Seaver & Bethel, on *Populus* leaves). Describing the species Arendholz (1979) provided beautiful SEM photographs of the solid projections. The solid projections on the hairs do not take color in Congo red; hairs are colored only at their basal part. Adding 4-10 % KOH causes the loss of refractiveness in all of the species, and if hairs are thereafter stained with Congo red, they appear as clearly colored.

Although the hairs of *Mollisina* resemble those found in *Hyalopeziza digitipila* and *Urceolella equiseti*, this is not necessarily the sign of a close relationship. In *Mollisina* the excipular cells are ornamented with solid projections similar to those on the hairs, a feature not seen in either

species. *Hyalopeziza digitipila* has solid projections on hairs only and in *U. equiseti* the excipular cells bear true hairs only. The genus *Dendrotrichoscypha* Svrček bears the closest resemblance to *Mollisia*, and in fact, type studies of both *D. epilobii* (Vel.) Svrček and *D. cretacea* (Vel.) Svrček have revealed that they bear typical *Mollisia*-hairs with solid projections. The solidness is seen clearly in cotton blue mounts but is very hard to notice in Melzer's reagent. The generic limit between these two genera has been discussed by Arendholz & Sharma (1984) and Sharma et. al. (1986).

The genus *Mollisia* appears to be a natural genus with uniform morphological and chemical characters and is best accommodated in the Hyaloscyphaceae.

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TRISCELOSPORIUM VERRUCOSUM GEN. ET SP. NOV., A
DEMATIACEOUS AERO-AQUATIC HYPHOMYCETE WITH
TETRARADIATE CONIDIA

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Triscelosporium verrucosum gen. et sp. nov., a dematiaceous aero-aquatic hyphomycete with tetraradiate conidia from submerged decaying leaves is described.

The fungus described in this paper was found sporulating on pieces of decaying leaves collected from the bottom of a small freshwater stream at the Lepar Forest Reserve, Pahang, Malaysia. The fungus appeared on the leaves within 3 – 5 days of incubation in moist chamber at 25° – 28° and continued to sporulate for 3 – 4 weeks. Since it does not appear to agree with any known taxa, the new genus *Triscelosporium* is erected to accommodate it.

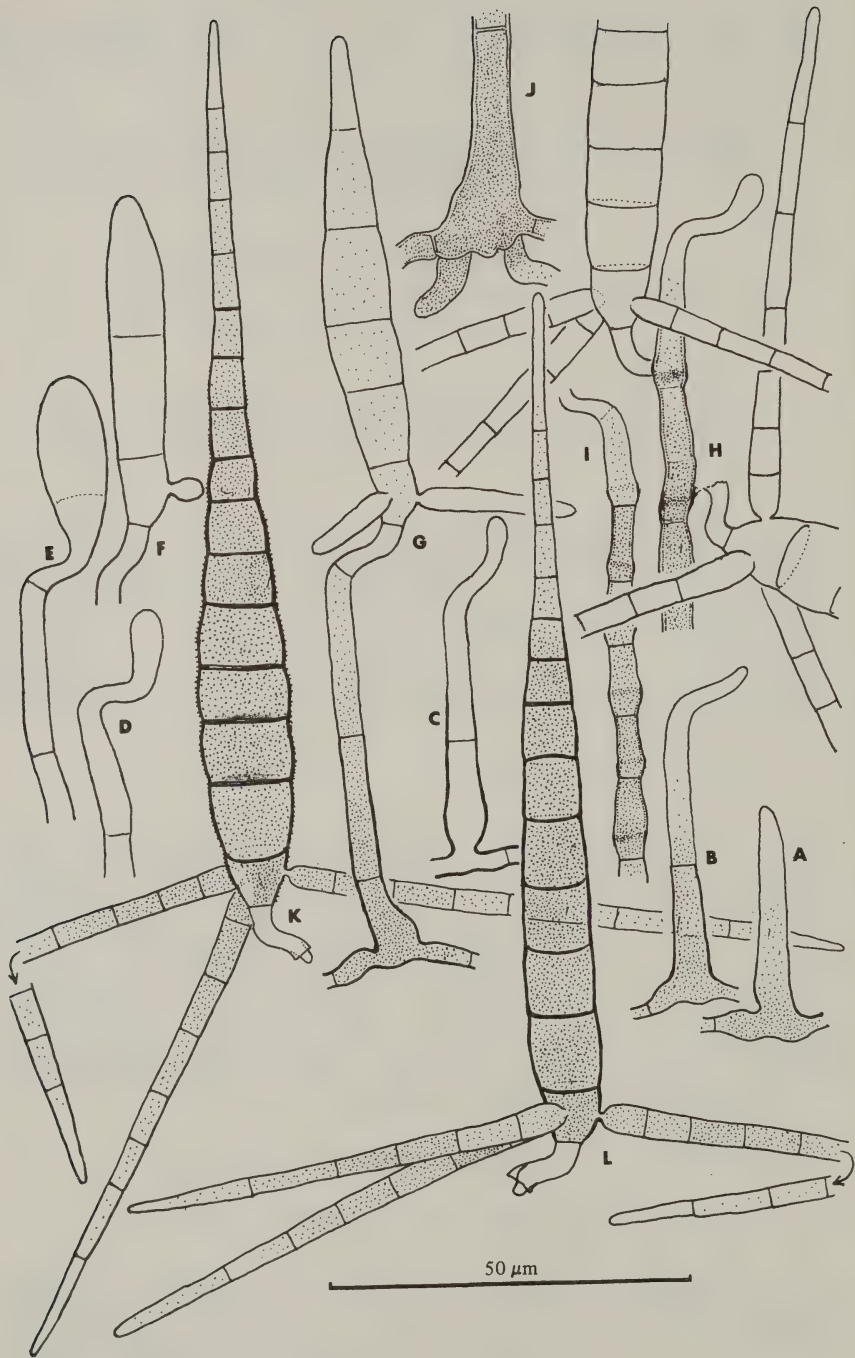
Triscelosporium gen. nov.

Coloniae effusae, plerumque inconspicuae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis laevibus, brunneis, ramosis, septatis compositum. Conidiophora macronematosa, mononematosa, solitaria, erecta, simplicia, raro ramosa, recta vel flexuosa, brunnea, septata, ex mycelio superficiali orientia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, prolificantes percurrentes. Conidia aerogena, solitaria, sicca, tetraradiata, brunnea, verrucosa, axis obclavata, multiseptata, 3 brachiis in ordine eadem a cellula basali orientes.

Species typica *Triscelosporium verrucosum*.

Triscelosporium verrucosum sp. nov. (Figs. 1 – 2)

Coloniae effusae, plerumque inconspicuae. Mycelium partim superficiale, partim in substrato immersum, ex hyphis laevibus, brunneis, ramosis, septatis, 2 – 3 μ m latis compositum. Conidiophora macronematosa, mononematosa, solitaria, erecta,

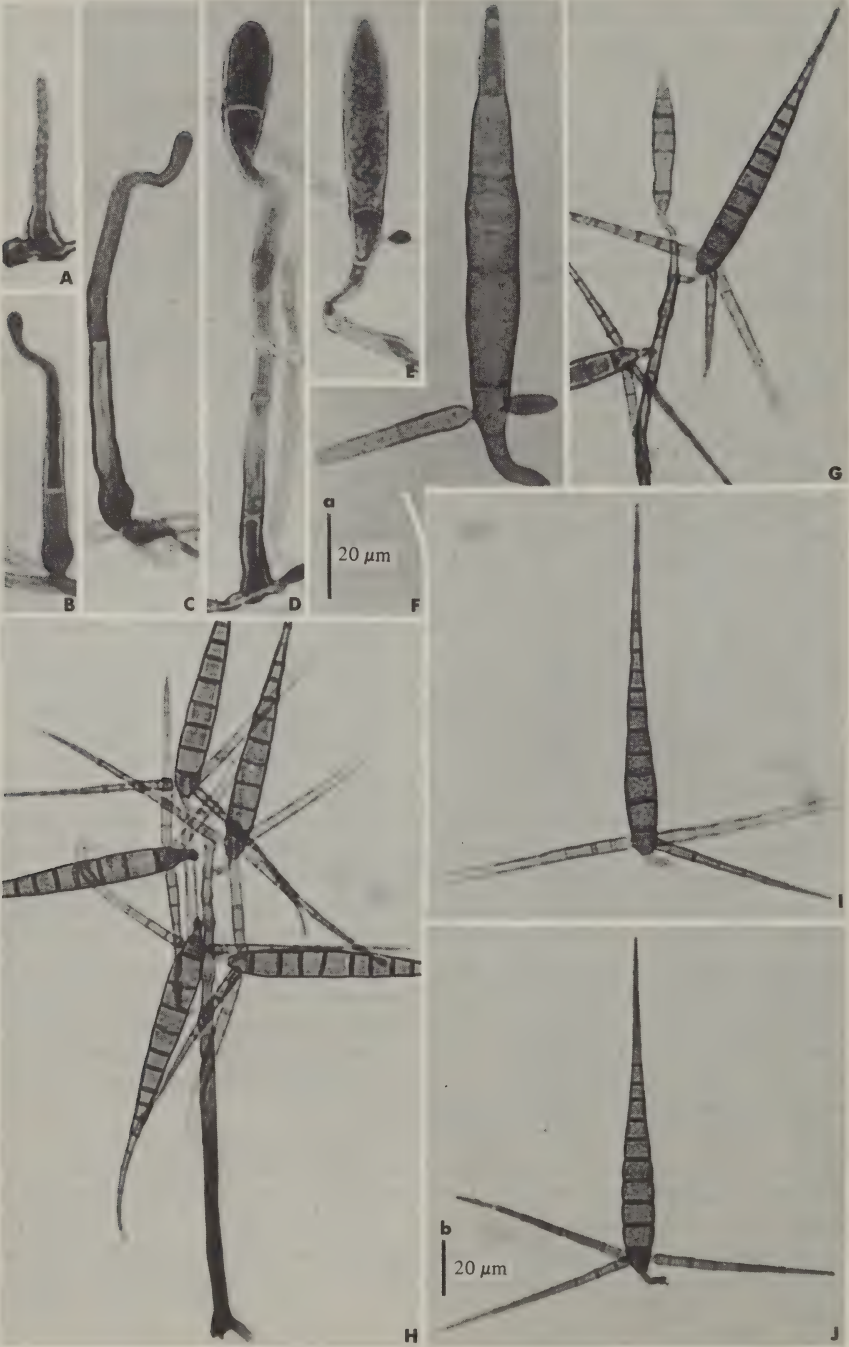


simplicia, raro ramosa, recta vel flexuosa, brunnea, 2 – 12 septata, 40 – 265 μm alta, 4 – 5 μm lata, ex mycelio superficiali orientia. Cellulae conidiogenae in conidiophoris incorporatae, terminales, monoblasticae, proliferantes percurrentes. Conidia acrogena, solitaria, sicca, tetraradiata; axis principalis obclavata, verrucosa, recta vel leviter curva, 12 – 16 septata, 118 – 141 μm longa, 8 – 12 μm crassa, pallide brunnea, apice subhyalinis; in cellula basali 3-brachiis in ordine eadem orientes, 54 – 108 μm longis, 4 – 7 μm crassis, 5 – 12 septati pallide vel modice brunneae, apicibus hyalinis, verruculosa, et 1.5 μm in affixionis constrictione.

Ex foliis angiospermis putrescentibus in flumine immersis, Lipar Forest Reserve, Pahang, Malaysia, July 1986, A.J. Kuthubutheen (IMI 313479 holotypus est).

Colonies effuse, usually inconspicuous. Mycelium partly superficial, partly immersed, composed of smooth, pale brown, branched, septate 2 – 3 μm wide hyphae. Conidiophores macronematous, mononematous, solitary, erect, simple, rarely branched, straight to flexuous, dark brown below, becoming pale and narrower above, arising from the superficial hyphae, 40 – 265 μm long, 4 – 5 μm wide, thick-walled, smooth, expanded basal cell 10 – 14 μm wide with the base clearly appressed to the cuticle. Conidiogenous cell integrated, terminal, monoblastic, pedicillate, proliferating percurrently, annellation inconspicuous. Conidia acrogenous, solitary, dry, tetraradiate, consisting of an obclavate thick-walled main axis, 12 – 16 septate, 118 – 141 μm long, 8 – 12 μm at the widest point, tapering gradually to 1.5 μm at the acute apex, distinctly verrucose with low warts, pale brown, occasionally constricted at the septa, the last 2 – 3 distal cells lighter in colour. The 3 downwardly radiating arms are produced in succession, arising equidistantly from one another from around the basal cell. The arms are cylindrical, tapering gradually to the acute tip, 54 – 108 μm long, 4 – 7 μm wide, 5 – 12 septate, minutely verrucose, pale-brown, except for the last two distal cells which remain lighter in colour and are abruptly constricted to 1.5 μm at the attachment to the basal cell. Conidia are liberated by a break across the septum of the narrow, curved or twice-bent pedicel.

Fig. 1. *Triscelosporium verrucosum*. (A – G) Conidiophores with conidia at different stages of development on agar arranged in a developmental series; (H – I) the distal portion of conidiophores showing conidial detachment and percurrent proliferations; J. The bulbous base of a conidiophore; (K – L) two typical tetraradiate conidia.



The whole pedicel measuring 8 – 12 μm long, 2 – 2.5 μm wide thus remains attached to the fallen conidium.

Other specimen examined. On submerged decaying leaves of angiosperm, Pasuh Forest Reserve, Negri Sembilan, A.J. Kuthubutheen, Jan 1987, IMI 313480.

Observations on numerous conidiophores bearing conidia show that the conidia do not become completely detached from the conidiophores but remain attached by a very narrow section of the wall of the pedicel. Even when the conidia are fully detached they tend to remain in situ due to the tangled arms. Up to 8 conidia have been observed to remain in situ on a conidiophore. After breaking of the pedicel wall the conidiophore proliferates percurrently. The tip resumes growth, sometimes develops a septum and proceeds to grow for some distance before producing the next characteristically bent conidial initial at a higher level. The distance between successive conidia ranges from 7 – 17 μm . The process is repeated several times and results in a conidiophore up to 265 μm long and 12 septate.

Conidia germinate soon after their release by producing a germ tube through the broken wall of the pedicel. On agar media they germinate within 24h by producing germ tubes from the tips of the arms or axis. On 2% MA or CMA the colonies are dark to black, raised in the centre with dark grey compact aerial mycelium. The fungus is slow growing attaining a diam of 18 mm in 3 weeks at 25° – 28°. Sporulation was poor on dry agar, but when suspended in little water conidia were formed abundantly on the exposed areas. Conidia formed on agar are similar in shape and size to those formed on the leaf pieces.

The combination of characters exhibited by *T. verrucosum* do not fit exactly those of any previously described genus of dematiaceous hyphomycetes. In terms of conidium morphology and proliferation of the conidiogenous cells, *T. verrucosum* shares some characters with *Teratosperma singulare* Sydow (Ellis, 1957). The morphologically distinct, verrucose terminal conidia of *T. verrucosum* formed on the delicate pedicel, however, suggests that the two taxa are not closely related and should not, therefore, be considered congeneric. *Chaetendophragma* Matsushima (1971) could be

Fig. 2. *Triscelosporium verrucosum*. (A – F) Conidiophores with conidia at different stages of development on agar arranged in a developmental series; (G – H) conidiophores with mature conidia from leaf; (I – J) two typical tetrastrate conidia from leaf. A – F, scale a; G – J, scale b.

considered close to the present genus differing, essentially, in the positioning of the lateral arms, the broad truncate base and the pronounced percurrent proliferation of the conidiogenous cells. The etymology of the present genus refers to its resemblance to *Triscelophorus* Ingold (1943) particularly *T. acuminatus* Nawawi (1975), a common tropical aquatic hyphomycete with unpigmented, thin-walled conidia.

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TETRABRACHIUM ELEGANS GEN. & SP. NOV.,
A HYPHOMYCETE WITH TETRARADIATE CONIDIA

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Tetrabrachium elegans gen. & sp. nov. a dematiaceous hyphomycete with tetraradiate conidia from submerged leaves is described and illustrated. The septate conidial arms which arise from a central sphere bear a characteristic vacuole at the apex of each arm.

The present paper reports the growth and sporulation in nature and in culture of a new dematiaceous hyphomycete recently collected on submerged decaying leaves of an angiosperm from the bottom of a small freshwater stream at the Forest Research Institute, Malaysia. The fungus sporulated profusely on the leaf surface within 2 days of incubation in a moist chamber at 25° – 28°.

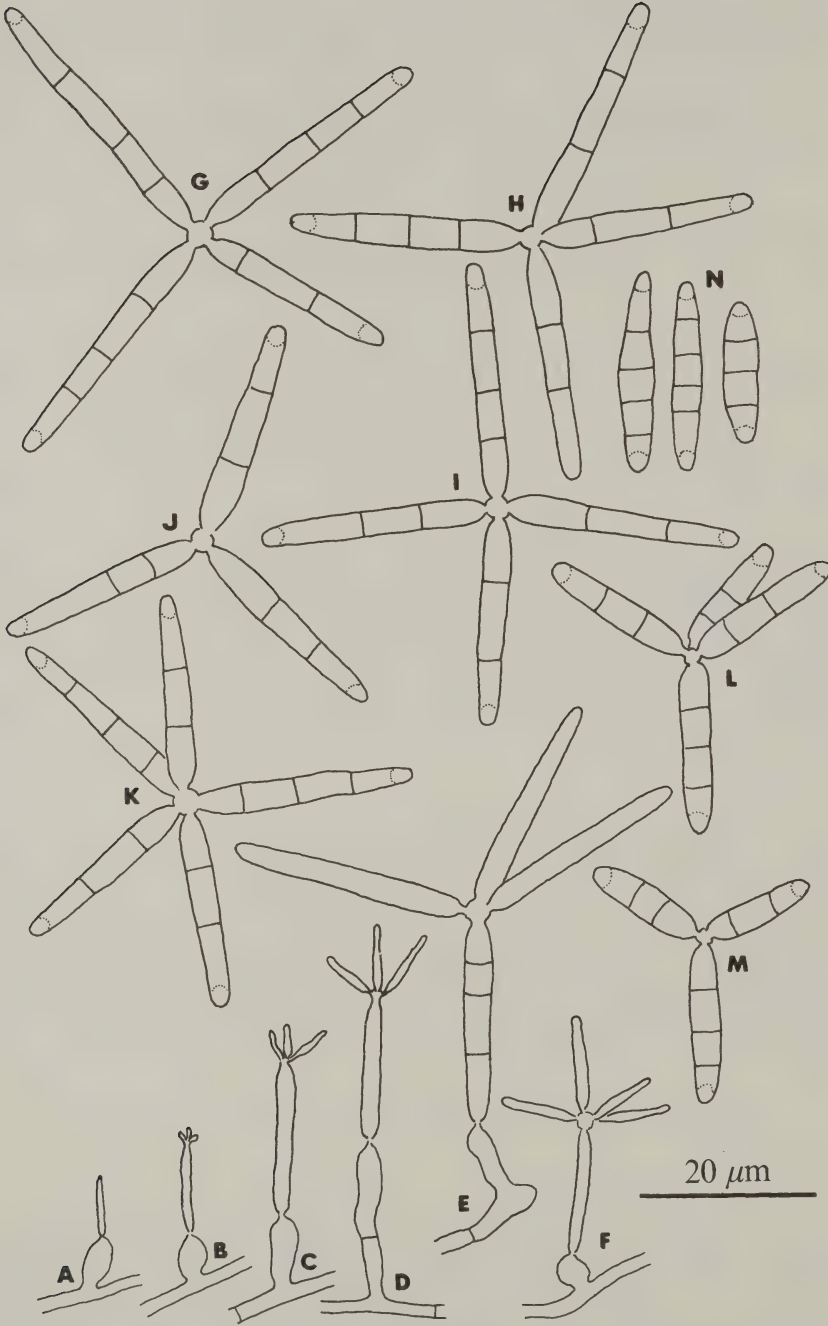
Tetrabrachium gen. nov.

Fungi Imperfecti; Hyphomyces dematiacei. Mycelium ex hyphis ramosis, septatis, pallide fuscis vel pallide brunneis. Conidiophora ex hyphis vegetativis lateralibus vel terminalibus, solitaria, simplicia vel parce ramosa, cuneata vel clavata, continua vel septata, laevia, pallide brunnea. Cellulae conidiogenae ad conidiophora apicalia. Conidia ex pedicellis conidiophora singulatum oriunda, tetraradiata, raro cum ramis 2 vel 4, solitaria, rami coronata simul gemmantia, pallide brunnea, levium vel minute verrucosum, basi subconstricti.

Species typica *Tetrabrachium elegans*.

Tetrabrachium elegans sp. nov. (Figs. 1 – 2)

Fungi Imperfecti, Hyphomycetes dematiacei. Mycelium ex hyphis laevibus, ramosis, septatis, pallide fuscis vel pallide brunneis, 1.5 – 2.5 μ m latis compositum. Conidiophora ex hyphis vegetativis lateralibus vel terminalibus, macronemata, mononemata, solitaria, simplicia, parce ramosa, cuneata vel clavata, continua



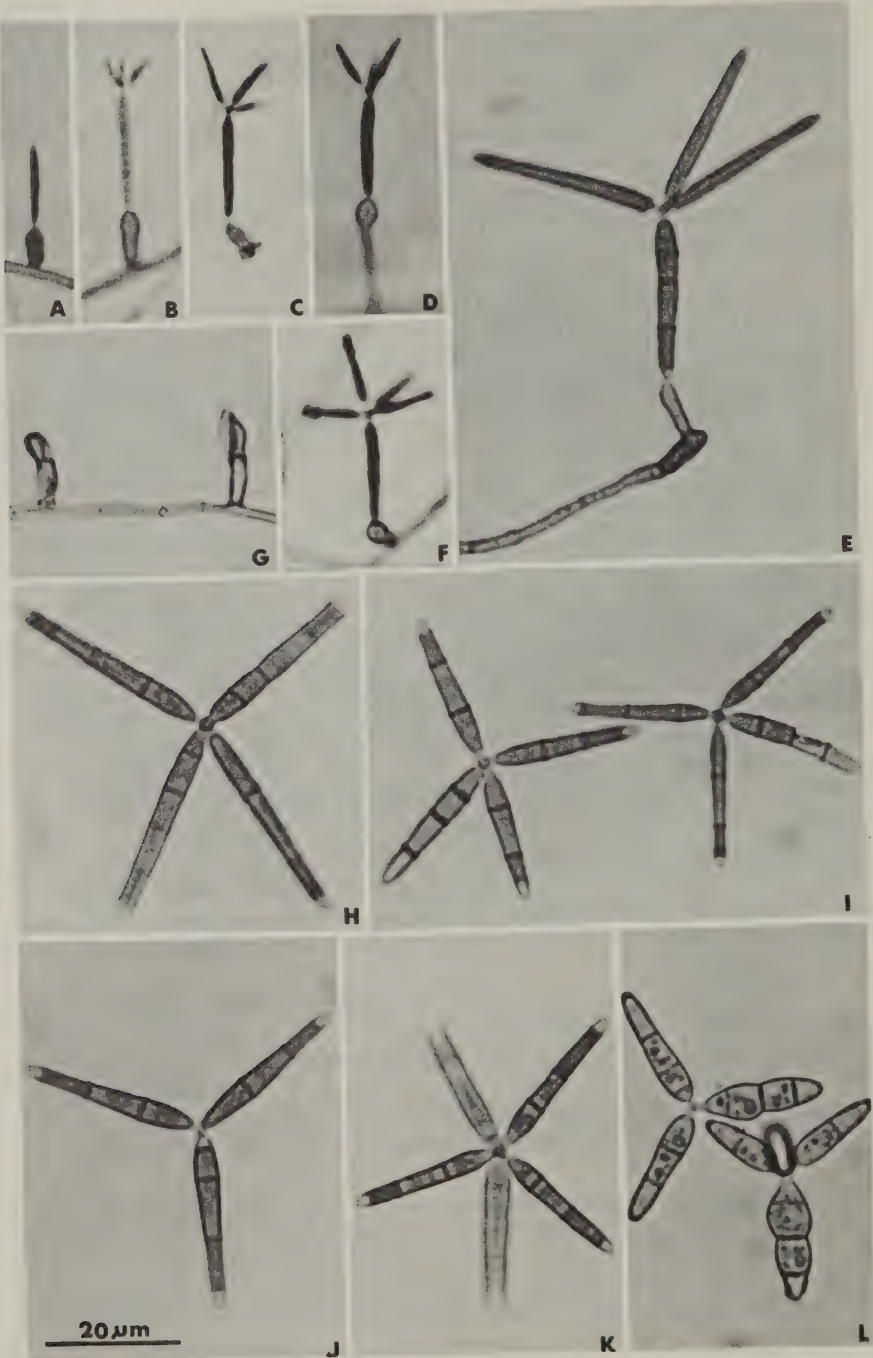
vel 2-septata, 8 – 32 μm longa, 3 – 4 μm lata. Cellulae conidiogenae ad conidiophora apicalia. Conidia ex pedicillis conidiophora singulatum oriunda, tetraradiata, raro cum ramis 2 vel 4, 24 – 34 μm longa, 3 – 4 μm lata, 2 – 4 septata, pallide brunnea, levia vel inconspicue verruculosa; rami coronata simul gemmantia, apice vacuolata, basi subconstricti.

Ex foliis angiospermis putrescentibus in flumine immersis, Forest Research Institute Malaysia, October 1986, A. Nawawi (IMI 313481 holotypus).

On the leaves the mycelium is mostly superficial forming a loose web, occurring in patches, composed of smooth, branched, septate, pale fuscous to pale brown 1.5 – 2.5 μm wide hyphae. Conidiophores lateral, occasionally terminal, arising from the aerial hyphae, macronematous, mononematous solitary, simple, rarely branched, cuneate to clavate, smooth, 0 – 2 septate, 8 – 32 μm long, 3 – 4 μm wide. Conidia were formed profusely within 2 days on the incubated leaf pieces. Each conidium starts as a minute hyaline bud at the tip of the conidiogenous cell. This primodium which will develop into the main axis of the conidium lengthens to become rod-shaped and a very short pedicel or denticle soon becomes apparent, connecting the developing conidium to the conidiogenous cell. When the axis reaches 13 – 17 μm long, 3 buds appear simultaneously from around its acute apex and elongate out divergently to form the arms. In the mean time the main axis becomes progressively darker and fatter with 2 – 3 septa. The apex of the main axis from where the arms arise develops into a small sphere. The conidia secede by a break in the denticle very close to the base of the axis, leaving a short, delicate, thread-like stump on the conidiophore. It appears that each conidiophore only produces a single conidium and there is no proliferation or regeneration of the conidiogenous cell. The spent conidiophore becomes devoid of protoplasm and collapsed.

The freed mature conidia are highly characteristic. They show a great uniformity of structure. Each consists of four divergent arms of more or less equal length and width. Of these one is the main axis and the others are terminal branches. Conidial arms are straight, cylindrical, tapering gradually to the subobtuse apex and somewhat constricted at the attachment to

Fig. 1. *Tetrabrachium elegans*. (A – E) Conidiophores with conidia at different stages of development from the leaf arranged in a developmental series. (F) A developing conidia with four terminal arms. (G – I) Typical tetraradiate conidia from leaf. (J – K) Conidia with 3 and 5 arms respectively. (L – M) Two conidia formed on dry agar. (N) Fusiform conidia formed on agar.



the central sphere, smooth to sparsely verrucose especially along the first half of its length, pale fuscous to pale brown, 2 – 4 septate, 24 – 34 μm long and 3 – 4 μm at the widest point. The central sphere measures 2 – 2.5 μm across. Most conidia are tetraradiate, but occasionally there are conidia with 3 or 5 branches. One characteristic feature of the conidium is the presence of a vacuole at the apex of each arm which develops when the conidium is near maturity. It is possible to distinguish the main axis from the later formed arms by careful examination. On average the main axis is slightly longer, usually 3 – 4 septate, and the remains of the broken denticles can be faintly detected.

Conidia germinate readily on agar media. On CMA the colony is compact, initially grey, turning olivaceous brown with a reddish tinge and finally dark olivaceous brown with age; reverse dark brown. Submerged hyphae are pale-brown, septate, branched, smooth, 1.5 – 3 μm wide. Aerial mycelium abundant, fluffy, loose, fuscous. Twenty day-old colonies reached a diam of 24 mm at 25° – 28°. Sporulation varies with the media used. On LCA conidia were formed abundantly on dry agar within 5 days. They tend to have shorter and fatter arms, mostly tetraradiate and occasionally triradiate. A few are fusiform 15 – 23 μm long $\times$ 3 – 4.5 μm wide, with rounded apices bearing the characteristic vacuole at both ends, smooth or minutely verrucose. On CMA and 2% MA sporulation was enhanced when squares of the colonies were incubated in shallow water; conidia being formed on the exposed areas. Under these conditions the conidia are similar in shape and size to those formed on the leaves.

The tetraradiate conidium of this fungus, with a central sphere to which the arms are narrowly attached and the vacuole at the tip of each arm makes it so characteristic. It cannot be confused with that of any of the other conidia of hyphomycetes (aquatic or aero-aquatic) so far described which have conidia with four long divergent arms (e.g. *Articulospora tetracladia* Ingold, *Lemonnieria aquatica* de Wild., *Isthmotricladia laeensis* Matsush., *Tridentaria glossopage* Drechsler, *Flabellocladia tetracladia* Nawawi). In these genera the single terminal hyaline conidium consists of a stalk at the end of which there are three fatter, longer divergent arms. In development these arms also arise and grow out simultaneously from the free end of the stalk and each is constricted near its insertion. Conidia with similar configuration and size to the present fungus have been described

Fig. 2. *Tetrabrachium elegans*. (A – F) Conidiophores and developing conidia from leaf. (H – K) Conidia from leaf. (L) Conidia from culture.

and illustrated by Nawawi (1985, Fig. 68) from a foam sample collected at the Gombak river, Malaysia.

In comparing *T. elegans* with other hyphomycetes previously described it is clear that the species which it resembles most is *Scolecobasidium tricladiatum* Matsush. (1971), first described from the Solomon Islands on decaying (not submerged) leaves. The differences between the two fungi are listed in Table 1.

Table 1. *Differences between Scolecobasidium tricladiatum and Tetrabrachium elegans*

S. tricladiatum

Conidia mostly triradiate; arms 12 – 20 μm x 3 – 4 μm , 1 – 2 septate; very constricted at point of origin and lacking a central sphere.

Conidiophores round to moniloid and irregularly branched.

T. elegans

Conidia mostly tetra-radiate; arms 24 – 34 μm x 3 – 4 μm , 2 – 4 septate, not so constricted at point of origin and with a distinct central sphere.

Vacuole present at tip of each arm.

Conidiophores cuneate to clavate rarely branched, 0 – 2 septate.

The concept of the genus *Scolecobasidium* Abbott has been considered and amended by Barron & Busch (1962) and Graniti (1962). According to de Hoog & von Arx (1973) and de Hoog (1985) *Scolecobasidium* is characterised by finely warted to echinulate 2- to many-celled T- or V-shaped conidia formed on ampulliform, often seriate and denticulate conidiogenous cells. De Hoog & von Arx (1973) erected the genus *Ochroconis* to accommodate most species of *Scolecobasidium* with ellipsoidal, clavate or fusiform conidia. *S. tricladiatum* appears to be unrelated to *Scolecobasidium*. Considering the confusion presently prevailing we are reluctant to include the present fungus in *Scolecobasidium*. The distinct conidial morphology of the present fungus merits emphasis at the generic level and it would be straining the limits of the genus *Scolecobasidium* to include it in this genus. A new generic name is, therefore, proposed.

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FUNGI ISOLATED FROM GYPSY MOTH EGG-MASSSES

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SUMMARY

Gypsy moth (Lymantria dispar L. - Lepidoptera: Lymantriidae) egg-masses from a natural infestation in Lane Co., Oregon were brought into the laboratory and incubated for periods of several weeks in moist chambers. A suite of 20 species of fungi were isolated, both from intact egg-masses and from surface-sterilized unhatched eggs. These included 15 species of hyphomycetes, a species of Phoma, three species of Mortierella, and a sterile sclerotial form. Several well-known entomopathogens proved almost ubiquitous on unhatched eggs. Many of the fungi listed were isolated from old egg-masses collected at one of the sites a year after the initial isolations were carried out.

INTRODUCTION

Although numerous fungi have been reported as parasites of larval, pupal, and adult stages of insects, few are known to be associated with insect eggs in terrestrial environments. Early, obscure, and probably anecdotal evidence for fungal parasitism of insect eggs has been reviewed by Madelin (1963). A later report (Dunbar et al., 1972) demonstrated the presence of Paecilomyces farinosus (Holm ex S.F. Gray) Brown & Smith in egg-masses of the gypsy moth and attempted to assess the degree of parasitism by the fungus through visual examination of eggs under the dissecting microscope. More recently other investigators have reported success in killing eggs of various insect pests with inocula of known entomopathogenic fungi (Lynch and Lewis, 1978; Rodriguez-Rueda, 1980; Riba et al., 1983; Villacorta, 1983; Poprawski et al., 1985).

Egg-masses of the gypsy moth and other insects with a similar life cycle should be particularly susceptible to attack by fungal pathogens. In such insects the egg stage comprises about nine months of the annual life cycle, during which time eggs are frequently exposed to cold wet conditions, which should favor fungal invasion. Further, the egg-masses are usually laid on bark or even under stones in close proximity to the soil. Bark and soil are more hospitable substrates for dormant propagules of fungi than are leaf surfaces or interior spaces within plants, where other species of herbivorous insects often lay eggs.

Since 1984 over 200,000 acres in Lane County, Oregon have been subject to various degrees of infestation by the gypsy moth. In January, 1985 I collected a number of egg-masses from a highly infested site in connection with a preliminary study to evaluate the possible pathogenicity of a strain of Trichothecium for gypsy moth eggs. Laboratory incubation of uninoculated, control egg-masses quickly revealed the presence of a number of fungi, several of them apparently pathogenic. This observation led me to carry out further collections and isolations, the results of which are reported below.

MATERIALS AND METHODS

All fungi were isolated from at least one of three sites, here designated Hot Spot Ridge, Cedar Hills Rd., and Rattlesnake Rd. The Hot Spot Ridge and Cedar Hills Rd. sites are located in the vicinity of Pleasant Hill, Oregon (T19S R2W Section 11); the Rattlesnake Rd. site is located near Dexter, Oregon (T19S R1W Section 19). All three sites are in Lane County 10-15 miles SW of Eugene, Oregon. Initial collections were taken from the Cedar Hills Road site on Jan. 24 and Jan. 30, 1985. Subsequent collections were made from all three sites early in March, 1985. Egg-masses were incubated for a period of 1-4 weeks at 21° C in sterile 120mm Petri plates on sterile filter paper with 0.5 ml sterile distilled water added. Fungi were isolated either by transferring spores from intact egg-masses or culturing from eggs rigorously surface-sterilized in 2% NaOCl. Cultures were started on Petri plates containing 2% Difco malt extract and 2% agar; transfers were made onto slant tubes containing V-8/Oat medium (50 ml V-8 juice, 50 g pulverized oat flakes, 10 g pulverized Wheaten, 20 g agar, and 950 ml distilled water). All cultures have been deposited with the USDA-ARS Collection of Entomopathogenic

Fungal Cultures (ARSEF) and may be obtained by writing to Dr. Richard Humber, USDA-ARS Plant Protection Research Unit, Boyce Thompson Institute at Cornell University, Tower Road, Ithaca, New York 14853-0331

RESULTS AND DISCUSSION

A list of fungi isolated from egg-masses is given in Table 1. Perusal of the list reveals several species which have been frequently reported and studied as pathogens of adult insects. These include Beauveria bassiana, Pae-cilomyces farinosus, and Verticillium lecanii. Others such as Acremonium berkeleyanum (Balazy, 1976a - listed as Acremonium butyri (van Beyma) Gams), Acrodontium crateriforme (De Hoog, 1972; Balazy, 1976a), Aphanocladium album (Humber and Soper, 1986), Filobasidiella arachnophila (Malloch et al., 1978), Penicillium thomii (Balazy, 1976b) and Tri-chothecium roseum (Humber and Soper, 1986) have been reported occasionally from entomogenous substrates, although their pathogenicity has not been established. The remainder have not been previously demonstrated on insects or their remains.

After the initial isolations were made, I attempted to assess the relative frequencies of infection by the various fungi. Thirty egg-masses from each collection site were brought into the laboratory in March, and viable eggs were allowed to hatch. After larval emergence was complete, the remaining eggs (about 10,000 of a total sample of 15,000) were cleaned of egg-hairs, and a representative subsample of unhatched eggs from each of the egg-masses was surface-sterilized and placed either in slants (one egg/slant) or in Petri plates containing 2% malt agar. Eggs were scored for the presence of internal fungal infections after one week and then at irregular intervals over a period of six weeks. A total sample of about 6,000 eggs was examined. Virtually 100% of the unhatched eggs proved to be infected with fungi. Although all species previously isolated were seen again, only a few were truly prevalent; these included: Beauveria bassiana, both species of Fusarium, Pae-cilomyces farinosus, Spicaria coccospora, and Verticillium lecanii. It should be noted however, that all of the above species of hyphomycetes grow rapidly in culture and that multiple infections with one of these and a more slowly growing fungus such as Filobasidiella would probably have been missed. Further, not all of the egg-mass fungi may be

Table 1. List of fungi isolated in culture from gypsy moth egg-masses. ARSEF numbers refer to accession numbers in the USD-ARS culture collection, Boyce Thompson Institute, Ithaca, New York

<u>ARSEF#</u>	<u>FUNGUS</u>
2067	<u>Acremonium berkeleyanum</u> (Karst.) W. Gams
2070	<u>Acrodontium crateriforme</u> (van Beyma) de Hoog
2068	<u>Aphanocladium album</u> (Preuss) W. Gams
2054	<u>Beauveria bassiana</u> (Balsamo) Vuill.
2058	<u>Filobasidiella arachnophila</u> Malloch, Kane, & Lahaie
2060	<u>Fusarium avenaceum</u> (Fr.) Sacc.
2059	<u>Fusarium merismoides</u> Corda
2069	<u>Humicola</u> sp.
2062	<u>Mortierella clausenii</u> Linnem.
2061	<u>Mortierella hyalina</u> (Harz) W. Gams
2063	<u>Mortierella</u> sp. nov.
2054	<u>Paecilomyces farinosus</u> (Holm ex S.F. Gray) Brown & Smith
2056	<u>Penicillium thomii</u> Maire
2072	<u>Phialophora</u> sp. (close to <u>P. malorum</u> Fr.).
2071	<u>Phoma cava</u> Schulzer
2064	<u>Spicaria coccospora</u> Drechsler
2055	<u>Trichothecium roseum</u> Link:Fr.
2065	<u>Verticillium fungicola</u> (Preuss) Hassebr.
2066	<u>Verticillium lecanii</u> (Zimmerm.) Viegas
2073	indeterminate sterile sclerotial fungus

internal parasites; Acrodontium crateriforme, for example, seems to be specifically associated with egg-mass hairs.

Theoretical considerations suggest that persistence of a pathogen in the environment is of crucial importance if it is to function as a natural biological control agent (Anderson and May, 1981). Control of the gypsy moth by a fungal egg-parasite would require that the fungus persist at least through the summer months between egg hatch and new egg production. Survival in natural populations during long-term cyclical fluctuations would probably require that a fungus persist for several years outside the host. Consequently, it was of interest to discover which of the above fungi might be found in one-year-old egg-masses. Collections of old egg-masses were made on April 14, 1986 at the Cedar Hills site approximately one year after all viable eggs at the site had hatched. The following fungi were identified by simple visual inspection of egg-masses after one week of incubation in a moist chamber: Acrodontium crateriforme, Beauveria bassiana, Paecilomyces fariosus, and Verticillium lecanii. Crude bulk cultures of the egg-masses yielded all of the above fungi as well as Acremonium berkeleyanum, Phialophora sp. and the sterile sclerotial fungus. Culture of surface-sterilized eggs further revealed both species of Fusarium, Humicola sp., and Phoma cava. Aphanocladium album, Filobasidiella arachnophila, all three Mortierella species, Penicillium thomii, Spicaria coccospora, Trichothecium roseum, and Verticillium fungicola were conspicuous by their absence.

The most recent introduction of the gypsy moth to Oregon is thought to have happened within the last five or six years. The evidence suggests that widespread infestation originated with just two or three highly localized introductions. It seems unlikely that all of the above fungi were introduced with the gypsy moth; far more likely is the prior but undetected occurrence in Oregon of many of these fungi on entomogenous substrates or their persistence as facultative saprotrophs in bark or litter. If such is the case, these and other inconspicuous microfungi should be expected wherever long-lived insect eggs remain dormant in warm, wet climates. Indeed, the overall level of mortality seen in the egg-masses sampled here (65%) suggests that entomogenous fungi may strongly select against Lymantriid-like life-cycles in such climates.

ACKNOWLEDGEMENTS

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MARASMIUS SALALIS, A NEW PACIFIC COAST NORTH AMERICAN SPECIES

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SUMMARY

Marasmius salalis, a new species, is described from coastal British Columbia and Washington on *Gaultheria shallon* leaves and branches. It was described under the misapplied name *M. copelandii* in Fungi Canadenses No. 214.

INTRODUCTION

Although C. H. Peck never collected on the west coast of North America, he described several new species of fungi from this region which had been sent to him. *Marasmius copelandii* Peck (1904; as *M. "copelandi"*) was named after E. B. Copeland based on specimens on leaves of *Lithocarpus densiflora* (H. & A.) Redh. from Woodside, California. The name *Marasmius copelandii* had remained relatively obscure until Redhead (1982) described under this name, west coast collections of a *Marasmius* on leaves of *Gaultheria shallon* Pursh. allied to *M. olidus* Gilliam and *M. prasiomus* Fr. More recently, over 25 collections of *M. copelandii* from 14 different counties in California were studied and found consistently to differ from the more northern taxon on *Gaultheria* leaves (Desjardin 1987). Furthermore, *M. olidus*, described on oak leaves from Michigan (Gilliam 1975), is now considered to be an eastern North American diminutive variety of *M. copelandii*, *M. copelandii* var. *olidus* (Gilliam) Desjardin (1987).

The fungus described and illustrated in Fungi Canadenses No. 214, a series available at major mycological libraries, is here given the new name, *Marasmius salalis*, which refers to its usual substrate, dead and fallen leaves and branches of salal (= *Gaultheria shallon*, see Szczawinski 1962). The fungus also has been found on leaves of *Mahonia nervosa* (Pursh) Nutt.; thus, the coriaceous texture and longevity of senescent leaves of both hosts may be significant. For a description, illustrations, and collection data see Redhead (1982).

MARASMIUS SALALIS Desjardin & Redhead, sp. nov.

Pileus 12-16 mm lat., *convexus* vel *planoconvexus*, *striatus*, *bubalinus*, *siccus*. *Lamellae* *adnatae*, *albidae* vel *bubalinae*. *Stipes* 33-46 x 1-3 mm, *tomentosus*, *subinsitituous*, *lentus*, *apice* *albido*, *base* *castaneo* vel *testaceo*. *Rhizomorphae* *tomentosae*, *testaceae*, *acuminatae*, *breves*. *Odor* et *sapor* *fortiter alliacei*. *Basidiosporae* 15-19.2 x 3.2-5.1 μ m, *comalae* (*clavatae* et *curvatae*), *inamyloideae*, *hyalinae*, *leves*. *Basidia* *tetraspora*, *clavata* vel *subcapitata*, 32-43 x 8-9.5 μ m. *Cheilocystidia* 25-55 x 9-10 μ m, *polymorphae*, *hyalinae*, *ellipsoideae*, *clavatae* vel *coralliformes*. *Pileocystidia* *polymorphae*, *congestae*, *hyalinae* vel *subhyalinae*, *leves* vel *coralliformes aliquantum*, vel *brunneae* et *pachydermae mixtae*. *Caulocystidia* *capillacea*, *hyalina* vel *brunnea*, ad 500 x 10-20 μ m, *parietibus crassis*. *Fibulae* *adsunt*. *Hyphae* *inamyloideae*.

In foliis et ramis senescentibus Gaultheris shallis et Mahoniis nervosis.

Holotype: DAOM 175254: Gordon Bay, Lake Cowichan, Vancouver Island, British Columbia, Canada, S. A. Redhead 3343, Oct. 4, 1979.

Paratypes: Canada: British Columbia: DAOM 175251, 170680, 141972, 96371 (see Redhead 1982 for data); Queen Charlotte Is., Graham I., Naikoon Prov. Park, Sept. 21, 1982, S. A. Redhead 4455 (DAOM 190873). U.S.A.: Washington: Imshaug 2035, Murrill 580 (see Desjardin 1987 for data); Kittitas Co., Meany Ski Hut, Oct. 11, 1975, R. Halling 950 (SFSU); vicinity of Cle Elum, Oct. 11, 1975, H. D. Thiers 35120 (SFSU).

Fresh specimens have been seen from Oregon but were not retained.

ACKNOWLEDGEMENTS

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SOME NEW SPECIES AND NEW RECORDS
OF DISCOMYCETES IN CHINA. II

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ABSTRACT

Two species of discomycetes from Chian have been studied. A new species is described as *Lambertella guizhouensis*. *Sowerbyella kaushalii* is transferred to *Aleurina*.

1. A NEW SPECIES OF *LAMBERTELLA* HÖHNEL FROM GUIZHOU

When the senior author studied at the Farlow Herbarium of Harvard University, some of the Chinese collections in the General Herbarium were examined. Among them, a characteristic fungus was found which had been collected in Guizhou Province in 1931, labelled as "*Velutinaria*," with a wine-colored hymenium. The black stipe base, the brown ascospores, and the structure of the ectal excipulum indicate that it is a species of *Lambertella*. The morphology of this fungus differs from that of the other species in this genus, and the fungus is treated as new.

Lambertella guizhouensis Zhuang & Korf, sp. nov. (FIG. 1)

Ab *L. jasmini excipuli ectalis strato exteriori et stipite ex textura angulari vice texturae prismaticae compositis, ascosporis minoribus, ascis multo brevioribus porum habentibus exhibentem speciem productam J— vice J+ (ut dicitur), et pilis cylindricis vice pilorum apicaliter tumidulorum*; ab *L. spadiceo-atra excipuli ectalis strato interiore crassiore, stipite ex textura angulari vice texturae prismaticae composito, et eis partibus hymenium componentibus peculiaribus pigmentiferis apicaliter torulosus absentibus differens*.

Apothecium discoid, 0.6-1.0(-1.5) mm in diam when dry, stipitate, up to 1 mm high, hymenium rosy in color, bright vinaceous to dark vinaceous at maturity, and vinaceous to nearly black when old, receptacle light brown to brown when dry, surface furfuraceous, with black stipe base. Hairs

cylindrical, short, smooth-walled to slightly roughened, hyaline at flanks and light brown on the lower portion of stipe, ca. 30-40 μm long. Ectal excipulum 3-layered, covering layer very thin, 1-2 hyphal layers thick, giving rise to hairs; outer layer of textura angularis, ca. 22-28 μm thick, cell walls subhyaline; inner layer of textura porrecta, 28-47 μm thick, hyphae hyaline; stipe tissue of textura angularis in outer layer, axes of cells towards outside at an acute angle to axis of stipe. Medullary excipulum of textura intricata, hyphae hyaline. Subhymenium not easily distinguished. Asci 8-spored, subcylindrical to clavate, J— in Melzer's Reagent with 10% KOH pretreatment, with croziers, 60-64 x 6-7 μm . Ascospores uniseriate to biseriate, ellipsoid to lemon-shaped, brown within ascus, walls slightly punctate when fully mature, with two small guttules when young, nonguttulate at maturity, 6.7-8.8 x 3.5-4.7 μm . Paraphyses cylindrical, hyaline, not exceeding asci, 2 μm wide.

On stromatized wood of *Quercus* sp.

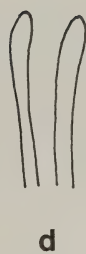
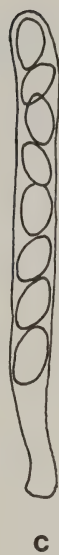
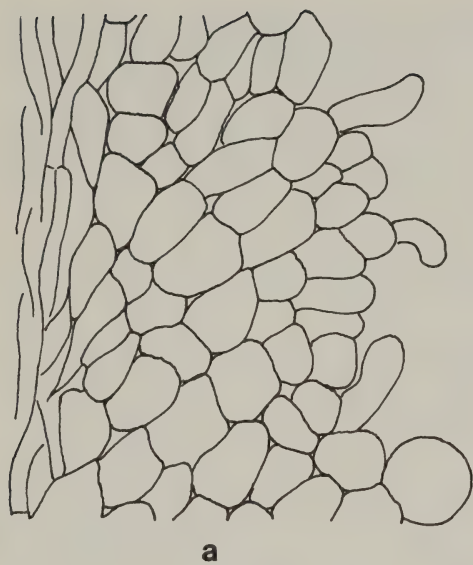
Holotype: On rotten stem of *Quercus* sp., Hui Hseing Ping, Kiang Kan Hsien, Guizhou (as Kweichow), China, elev. 1700 m, S. Y. Cheo 718, 16. X. 1931, FH-General Herb.

Notes: Using the keys to the species of the genus *Lambertella* (Dumont, 1971; Korf & Zhuang, 1985), we found that *L. jasmini* and *L. spadiceo-atra* are morphologically related to the fungus from China. *L. guizhouensis* and *L. jasmini* are similar in ellipsoid to lemon-shaped ascospores, spores brown within ascus, and with small guttules; the former differs from the latter in the angular cells instead of brick-shaped cells in the outer layer of the ectal excipulum and the stipe, smaller ascospores, very short asci which have a J— instead of J+ iodine reaction, and cylindrical instead of apically swollen hairs. *L. guizhouensis* is similar to *L. spadiceo-atra* in the shape and size of ascospores and of asci, spores brown within ascus, and J— iodine reaction of ascus apices, but is different from this species in the thicker inner layer of the ectal excipulum (22-28 μm vs. 5-22 μm), textura angularis instead of textura prismatica in the outer layer of the ectal excipulum and the stipe, presence of hyaline, normal paraphyses, lacking of pigmented, apically knobbed elements in the hymenium, and the very small spore guttules. *L. jasmini* and *L. spadiceo-atra* are both reported occurring on leaves, whereas, *L. guizhouensis* is on stromatized wood.

2. A SPECIES OF *ALEURINA* MASSEE FROM XIZANG

A number of Discomycetes of Xizang (Tibet) have been reported by Wang and Zang (1985). Recently, several discomycete specimens from this

FIG. 1. *Lambertella guizhouensis* (holotype). a. structure of stipe, b. three-layered ectal excipulum, c. an ascus, d. two paraphysis apices, e. three biguttulate ascospores, f. four hair apices. All x1000.



area were kindly sent us from Prof. M. Zang for our study. Xizang is in the southwest of China. Motou, where these specimens were collected, is located in the southeast of Xizang. It is a tropical rain forest region with 18-20 °C average yearly temperature, and has 3000-5000 mm rainfall per year. Among them there is a fungus which has stipitate apothecium, pustulate receptacle surface, brown cells in the ectal excipulum, and marked ascospores. It is a species of *Aleurina* which we describe as follows.

Aleurina kaushalii (Moravec) Zhuang & Korf, **comb. nov.** (FIG. 2)

= *Sowerbyella kaushalii* Moravec, Mycol. Helvet. 2: 94, 1986.

Apothecium discoid, margin more or less crenate, substipitate to stipitate, up to 20 mm in diam when dry; hymenium brownish orange when dry, receptacle brown to dark brown, pustulate. Ectal excipulum of textura angularis, 40-45 μm thick, cells light brown, thin-walled, ovoid to subspherical, ca. 10-24 μm in diam, axes of cells somewhat perpendicular to the exterior; pustules obvious, conical in shape, ca. 37-65 μm high, cells brown, ovoid, 10-18 μm long, arranged in chains. Medullary excipulum of textura intricata, 120-150 μm thick, hyphae hyaline, tightly interwoven running parallel to the outer surface. Subhymenium of textura intricata, very thin. Asci operculate, 8-spored, subcylindrical, J— in Melzer's Reagent, 220-245 x 13.2-14.8 μm , with crozier at base. Ascospores uniseriate, ellipsoid, biguttulate, walls ornamented with fine spines which are more densely distributed at ends than in the middle, 14.6-16.8 x 7.3-8.8 μm . Paraphyses simple, multiseptate, rigid, a few slightly bent, 3.7-4.4 μm wide at apex, and 3.0 μm below, not exceeding asci.

On mossy soil.

Specimen examined: on mossy soil under *Abies*, eastern slope of Mt. Xingkaizhuomari, Motou, Xizang, China, alt. 2600 m, Su Yong-ge 1351, 25. IX. 1982, HKAS 16484, CUP 61803 (ex HKAS 16484).

Isotype examined: on soil mixed with decayed wood in an angiospermous forest, Batasi, Darjeeling, West Bengal, India, Rishi Kaushal, 6. IX. 1979, Moravec Herb., CUP 61814 (ex PAN 18169).

Notes: The Chinese specimen was sent us just after we had finished our monograph of the genus *Aleurina* (Zhuang & Korf, 1986). The pustulate receptacle surface, excipular struture, pigmented ectal cells, marked, biguttulate ascospores, and soil habit indicate that it is a species of *Aleurina*. In the genus *Aleurina* a similar spore marking shape can be found on the ascospores of *A. echinata*. But *A. kaushalii* differs from that species in the smaller ascospores (14.6-16.8 x 7.3-8.8 μm vs. 23.1-28.7 x 13.7-17.6 μm), the fine, shorter, spine-like ornamentations on the ascospore surface (0.6-1.2 x 0.2-0.3 μm vs. 1.6-4.4 x 0.7-1.5 μm), and the strongly pustulate receptacle surface.

Morphologically, it is very similar to *Sowerbyella kaushalii* found in

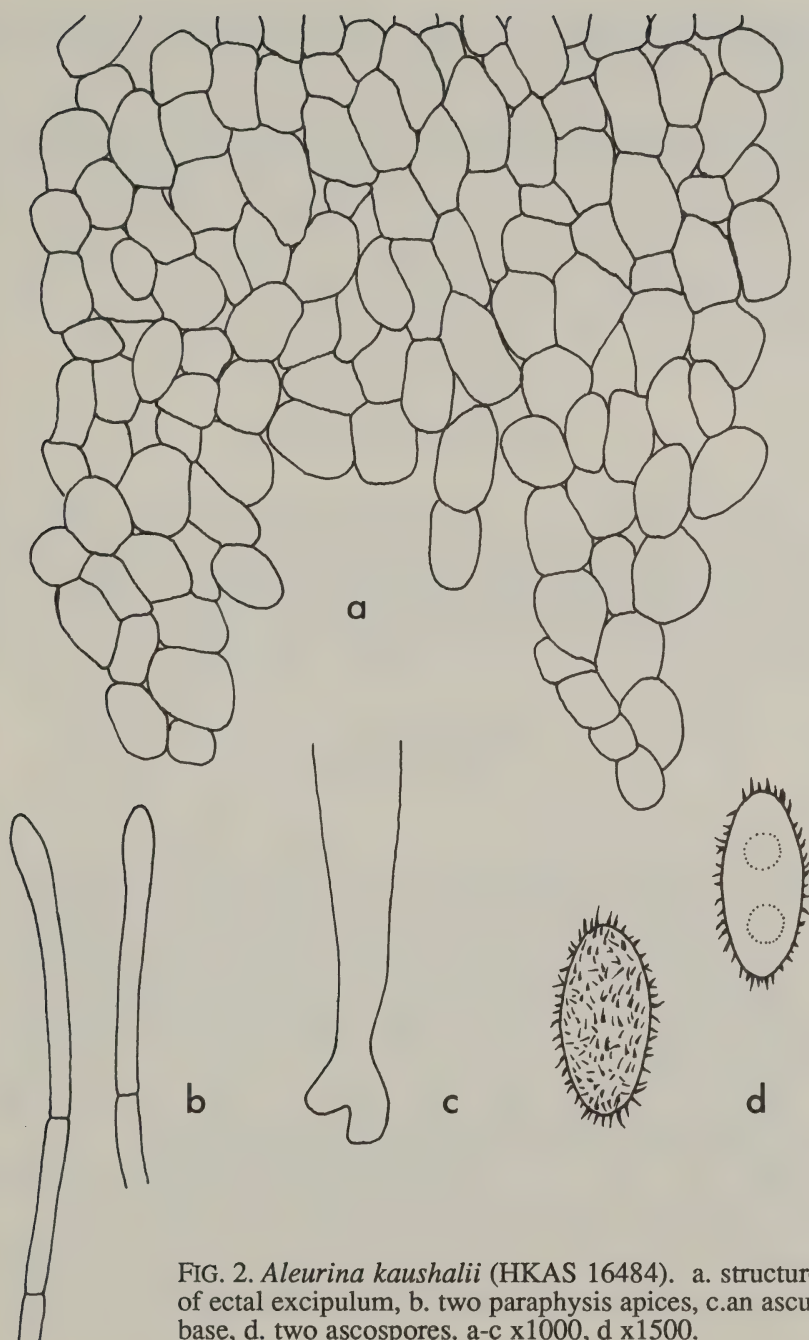


FIG. 2. *Aleurina kaushalii* (HKAS 16484). a. structure of ectal excipulum, b. two paraphysis apices, c. an ascus base, d. two ascospores. a-c $\times 1000$, d $\times 1500$.

India (Moravec, 1986), except for the smaller, short-stipitate apothecium, and smaller ectal excipular cells. After our examination of the isotype of *S. kaushalii*, we are convinced that the Chinese fungus is conspecific with the Indian one, and probably in a somewhat young stage. The only species of *Sowerbyella* recognized by Moravec (1985a, b, 1986) with a dark, pustulate excipulum and brown cells in the ectal excipulum was *S. kaushalii*. Removal of that species from *Sowerbyella* eliminates the need to expand the generic concept to accommodate it. Although the cell walls of the ectal excipulum of this fungus might not be as rigid as those of the other *Aleurina* species, it possesses many more features of *Aleurina* than of *Sowerbyella*. We thus transfer this species from *Sowerbyella* to *Aleurina*. The distribution of this species is thus extended to China, and of the genus *Aleurina* to India.

ACKNOWLEDGEMENTS

We deeply thank Dr. W. Dress (BH) for providing the Latin diagnosis, Dr. M. Zang (HKAS) and Dr. J. Moravec for sending specimens of *Aleurina* on loan, and Dr. D. H. Pfister and the staff of FH for kindly hosting the senior author during her study visit in that herbarium. Dr. Pfister also served as presubmission reviewer of this paper. An American Society of Plant Taxonomists Herbarium Travel Award to the senior author supported part of this study.

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Additions to *Phlebiella* (Corticaceae, Basidiomycetes), with notes on *Xenasma* and *Sistotrema*.

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Summary

Phlebiella is considered the appropriate genus for several species hitherto placed in *Aphanobasidium*, *Trechispora* and *Xenasmatella*. The following new combinations are proposed: *P. allantospora*, *P. ardosiacae*, *P. aurora*, *P. californica*, *P. christiansenii*, *P. fibrillosa*, *P. filicina*, *P. gaspesica*, *P. grisella*, *P. inopinata*, *P. lloydii*, *P. pseudotsugae*, *P. ralla*, *P. romellii* and *P. subnitens*. One species is described as new viz. *Phlebiella borealis*. *Uthatabasidium citrifforme* M.P. Christ. is identified as a *Sistotrema* and is an older name for *Sistotrema subangulisporum* Larss. & Hjortst. A lectotype is chosen for *Corticium rimicolum* Karst.

Donk (1957) united pleurobasidial species, with a more or less gelatinous fruitbody, within the genus *Xenasma* Donk, with *X. pruinsum* (Pat.) Donk as type species. Oberwinkler (1965) restricted *Xenasma* to species with cystidia and introduced *Xenasmatella* for non-cystidiate species. He also created *Acanthobasidium*, *Xenosperma* and *Litschauerella* for species with pleurobasidia but without a gelatinous fruitbody. All species with pleurobasidia were united in a family Xenasmataceae. Later Oberwinkler (1977) found that *Phlebiella vaga* (Fr.) Karst., type of *Phlebiella* Karst., has pleurobasidia and also that this species not could be generically separated from the type of *Xenasmatella*, *X. subflavidogrisea* (Litsch.) Oberw.. Consequently, *X. subflavidogrisea* was moved to *Phlebiella* together with the rough-spored species, *X. insperata* (Jacks.) Oberw. and *X. tulasnelloidea* (Höhn. & Litsch.) Oberw. The residual species in *Xenasmatella* were then left without a proper generic place until Jülich (1979) introduced *Aphanobasidium* to include the smooth-spored xenasmatoïd species.

Phlebiella vaga is better placed with other pleurobasidial species than with *Trechispora mollusca* (Fr.) Lib., type of *Trechispora*. However, we prefer to give *Phlebiella* the same circumscription as *Xenasmatella*. *Phlebiella* then becomes a rather large genus and it could be convenient to make a subdivision of it. We propose to divide *Xenasmatella* into three subgenera which conforms with the ideas of Oberwinkler (1977).

Karsten (1890) described *Phlebiella* with *P. vaga* as only species. Donk (1957) at first accepted the genus but later (Donk, 1963) changed his mind. He regarded Karsten's Latin diagnosis as a species description which 'cannot be taken as a valid *descriptio generico-specifica* since the species was not a new one'. We tried to analyze the Latin but could not arrive at a conclusion as to whether the diagnosis could be taken as a generic description. We find that practice is to give the nomenclatural rules a wide interpretation and we therefore regard *Phlebiella* as validly published.

Phlebiella Karst.,
Hedwigia 29:271, 1890.
Generic type: *Phlebia vaga* Fr.

Subgenus *Phlebiella*

Phlebiella ardosiaci (Bourd. & Galz.) Larss. & Hjortst. comb. nov.
Basionym: *Corticium ardosiacum* Bourd. & Galz., Hym. de France p. 234, 1928. — Synonym *Xenasmatella decipiens* Hjortst. & Ryv., Mycotaxon 9:515—16, 1979.

Phlebiella borealis Larss. & Hjortst. spec. nov.
Differt a Phlebiella insperata sporis distincte ellipsoidibus 5—6 × 3—4 μm nunquam adaxialibus concavis.

Holotypus: Norway. Nordland. Rana. Örtfjellmoen, on decayed *Pinus sylvestris*. 1982-08-17, leg. K.-H. Larsson No. 2721 (GB).

This species is the same as that treated by several authors under the name *Xenasmatella tenuicula* (Litsch.) Strid (*Corticium tenuiculum* Litsch., Ann. Mycol. 39:130, 1941). Litschauer's species certainly belongs in the genus *Trechispora* s. s. and shows characteristics typical for that genus e.g. fairly fragile fruitbody, terminal basidia, ampullate hyphae, and verrucose spores. It should be noted that Oberwinkler (1965) excluded this species from *Xenasmatella* because the basidia were terminal instead of pleural.

Phlebiella californica (Liberta) Larss. & Hjortst. comb. nov.
Basionym: *Xenasma californicum*, Mycologia 57:967—968, 1965.

Phlebiella christiansenii (Parm.) Larss. & Hjortst. comb. nov.
Basionym: *Cristella christiansenii* Parm., Eesti NSV Tead. Akad. Toim. Biol. Seer. 14(2):222, 1965.

Phlebiella fibrillosa (Hallenb.) Larss. & Hjortst. comb. nov.
Basionym: *Trechispora fibrillosa* Hallenb., Iran. J. Plant Pat. 14:75, 1978.

Phlebiella inopinata (Jacks.) Larss. & Hjortst. comb. nov.
Basionym: *Corticium inopinatium* Jacks., Can. Journ. Res. C, 28:718, 1950.

Phlebiella insperata (Jacks.) Oberw.,
Bibl. Mycol. 61:343, 1977.

(*Xenasmatella odontioidea* Ryv. & Lib.
Can. Journ. Bot. 56:2617, 1978.

We delay making a decision on the appropriate position of this taxon because the type has not been located.)

Phlebiella romellii (Hjortst.) Larss. & Hjortst. comb. nov.

Basionym: *Xenasmatella romellii* Hjortst., Mycotaxon 17:582, 1983.

(*Xenasmatella sanguinescens* Svrcek

Ceská Mykol. 27:205—206, 1973.

This species seems closely related to *P. vaga* and will be treated further in a separate paper.)

Phlebiella subflavidogrisea (Litsch.) Oberw.

Bibl. Mycol. 61:343, 1977

Xenasmatella tenuicula (Litsch.) Strid,

Wahlenbergia 1:83, 1975.

See *Phlebiella borealis*.

Phlebiella tulasnellodea (Höhn. & Litsch.) Oberw.,

Bibl. Mycol. 61:343, 1977.

Phlebiella vaga (Fr.) Karst.,

Hedwigia 29:271, 1890

Phlebiella subg. *Aphanobasidium* (Jülich) Larss. & Hjortst. comb. nov.

Basionym: *Aphanobasidium* Jülich, Persoonia 10:326, 1979. — Subgeneric

type: *Corticium subnitens* Bourd. & Galz.

Phlebiella aurora (Berk. & Br.) Larss. & Hjortst. comb. nov.

Basionym: *Corticium aurora* Berk. & Br., Outl. Br. fung. p. 276, 1860.

Phlebiella filicina (Bourd.) Larss. & Hjortst. comb. nov.

Basionym: *Corticium filicinum* Bourd., Rev. Scien. Bourb. 23:12, 1910.

Lectotypus: Bourdot no 6810 (PC)!typified by Liberta (1960).

We do not accept the treatment of Liberta (1960) and Oberwinkler (1965) who placed *Corticium pseudotsugae* Burt in synonymy with this species. *Corticium pseudotsugae* has clamped hyphae and occurs mainly on wood while *P. filicina* is devoid of clamps and seems to be obligate on ferns. All material at PC (about 30 specimens) as well as our own collections are growing on various kinds of ferns.

Phlebiella gaspesica (Liberta) Larss. & Hjortst. comb. nov.

Basionym: *Xenasma gaspeticum* Liberta, Mycologia 58:932, 1966.

Phlebiella pseudotsugae (Burt) Larss. & Hjortst. comb. nov.

Basionym: *Corticium pseudotsugae* Burt, Ann. Mo. Bot. Gard. 13:246, 1926.

Holotypus: J.R. Weir No 11617 (FH)!

See above under *P. filicina*.

Phlebiella subnitens (Bourd. & Galz.) Larss. & Hjortst. comb. nov.

Basionym: *Corticium subnitens* Bourd. & Galz., Hym. de France p. 224, 1928.

Holotypus Bourdot No. 30464 (PC)!

There is only one specimen of this species in Bourdot's herbarium which was mentioned in the protologue (Novembre. Sur pin, Causse Noir). The specimen should be accepted as a holotype (ICBN, T1).

Phlebiella subg. *Amyloxenasma* Oberw.,

Sydowia, Ann. Mycol. Ser. II, 19:35, 1965. — Subgeneric type: *Corticium grisellum* Bourd.

Phlebiella allantospora (Oberw.) Larss. & Hjortst. comb. nov.

Basionym: *Xenasmatella allantospora* Oberw., Sydowia, Ann. Mycol. Ser. II, 19:37, 1965.

Phlebiella grisella (Bourd.) Larss. & Hjortst. comb. nov.

Basionym: *Corticium grisellum* Bourd., Rev. Scien. Bourb. 35:17, 1922.

The lectotype (Bourd. No. 30049) is in very poor condition owing to treatment with mercuric chloride after it was designated by Liberta (1960). We suggest it is replaced by the following lectotype. *Lectotypus*, designated here: Bourdot No. 7901 (Galzin No. 8611). 13. III. 1911 (PC)!

Phlebiella lloydii (Liberta) Larss. & Hjortst. comb. nov.

Basionym: *Xenasma lloydii* Liberta, Mycologia 52:906, 1960.

A nomen novum for *Corticium lloydii* Bourd. & Galz. 1928; non *C. lloydii* Bres. 1926.

Phlebiella ralla (Jacks.) Larss. & Hjortst. comb. nov.

Basionym: *Corticium rallum* Jacks., Can. Journ. Res. C, 28:723, 1950.

Xenasma rimicolum (Karst.) Donk

Fungus 27:26, 1957. — *Corticium rimicolum*, Hedwigia 35:45, 1896.

Jackson (1950) carefully studied the *Peniophora rimicola* group and under *C. rimicolum* Karst. he mentioned an authentic specimen by Karsten (Oct. 1895) as type. At herb H. there are four specimens labelled *C. rimicolum*, but none with the above mentioned date. These specimens certainly represent what Karsten had in his hand when he described the species but none was listed in the protologue. A lectotype has to be chosen from them. Number 1402 and 1403, both from 29 Sept. are fairly large, well developed and preserved while 1401 and 1404 (29 Sept. and 28 Sept. respectively) are both mixed with *Amphinema byssoides* (Pers.:Fr.) John Erikss. and *Intextomyces contiguus* (Karst.) Erikss. & Ryv.

Lectotypus, designated here: Fennia. Tavastia australis. Tammela, Mustiala, Salvinen, in cortice Populi trem., leg Karsten 29 Sept. 1895, No. 1402 (H)!

Sistotrema citriforme (M.P. Christ.) Larss. & Hjortst. comb. nov.

Basionym: *Uthatabasidium citriforme* M.P. Christ., Dansk. Bot. Ark. 19:49, 1959. — Synonym: *Sistotrema subangulisporum* Larss. & Hjortst., Mycotaxon 5:479, 1977.

Specimens examined: *Uthatabasidium citriforme*. Denmark. Jylland, Rind Plantage, på nåletræ. 9 Oct. 1954, leg. M.P. Christiansen No. 3915, holotypus and only cited specimen (C)!— *Sistotrema subangulisporum*. Sweden. Västergötland. Tölsjö par., N.E. of Skåpeskulle, on decayed *Pinus sylvestris*. 23 Aug. 1969, leg Hjortstam No. 1508, holotypus.

Remarks: The holotype of *U. citriforme* is a fairly young specimen in rather poor condition. Most of the basidia are collapsed but a few observed have 4—6 sterigmata and typically urniform appearance. Fortunately there are a lot of spores and they are very characteristic for the species, subglobose to commonly

subangular. The figure in Christiansen (p. 47) is totally misleading as none of the spores is "two-apiculate". Presumably Christiansen has studied some shrunken and atypical spores. In the type of *S. subangulisporum* some basidia with only four sterigmata have been observed. This was neither noted by Christiansen nor by Eriksson et al. in *The Corticiaceae of North Europe* vol 7 (1984).

The species is a good representative of *Sistotrema* and seems related to *S. pistilliferum* Hauerslev.

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CALIFORNIA COLLYBIAS. I. COLLYBIA BAKERENSIS: A COMMON SNOWBANK AGARIC

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SUMMARY

Collybia bakerensis is redescribed and illustrated based on examination of numerous specimens from California and the Pacific Northwest. *Collybia bakerensis* is placed in section *Vestipedes* and is compared to *C. maculata*, *C. xylophila*, and *C. luxurians*.

Extensive collecting in the Sierra Nevada and Cascade mountain ranges of California has yielded numerous specimens of *Collybia bakerensis* A. H. Smith. In California, basidiocarps of this species usually develop in the spring from the inner bark of decayed, fallen *Abies* logs and are a common component of the snowbank mycota. A reexamination of the holotype specimen and available authentic material indicated a greater range of variation in macro- and micro-morphological features than that stated in the protologue (Smith, 1944). Our observations, including additional data from California specimens, warrant a redescription and illustration of *C. bakerensis*.

Color terms are taken from Kornerup and Wanscher (1978). Abbreviations used in citation of basidiospore size are as follows: $\bar{x}L$ = mean length; $\bar{x}W$ = mean width; $\bar{x}$ of $\bar{x}$ = mean of means; Q = length/width quotient; $\bar{x}Q$ = mean of Q .

COLLYBIA BAKERENSIS A. H. Smith, Bull. Torrey Figs. 1-8
 Bot. Club 71: 395. 1944 (non *C. bakeri* Dennis,
 Kew Bull. addit. ser. 3: 465. 1970).

Holotype: UNITED STATES. Washington. WHATCOM CO.: Baker
 National Forest, Anderson Creek, 19 Aug 1941,
 A. H. Smith 16278 (MICH!).

BASIDIOCARPS putrescent, not reviving. PILEUS 5-40 mm broad, convex with incurved and even margin when young, becoming plano-convex or plane with decurved or rarely uplifted and wavy margin in age; surface dull, opaque, dry to moist, smooth, glabrous or rarely granulose or appressed fibrillose in age; white overall when young, at maturity the disc remaining white or often becoming dingy buff, pale greyish orange (6B3) or pinkish to reddish grey (7B8, 8B8), margin white or pale pinkish white (7A2); context 0.5-4 mm thick, soft, white. ODOR and TASTE not distinctive. LAMELLAE adnate, adnexed to sinuate-emarginate, eventually with a slightly subdecurrent tooth, close or crowded, narrow or moderately broad [1-3.5(5) mm], thin, white or flushed pinkish in age, rarely stained sordid yellowish where bruised; edges even or slightly fimbriate-pubescent (under a lens), entire, concolorous, whitish-crystalline when dried; lamellulae in 2-3 series. STIPE (5)10-25(40) mm long, (1)3.5(5) mm thick, terete, equal or slightly enlarged downward with a subbulbous base, typically curved, subinsititious or non-insititious and arising from a small, floccose, white mycelial pad, stuffed to hollow, white overall when young, hysterochroic; apex pruinose, remaining white in age; base pubescent or with scattered appressed fibrils, glabrescent, becoming pink (7A2) to greyish red (8C3), finally reddish brown (9D4, 9D5).

BASIDIOSPORES from four-spored basidia: (5.4)5.6-7.6 (8.1) X 3.1-4.7(5) μm [$\bar{x}_L = 5.93$ -6.86 μm , $\bar{x}_W = 3.3$ -4.54 μm , $\bar{x}$ of $\bar{x} = 6.42$ X 3.73 μm ; $Q = 1.14$ -2.37, $\bar{x}Q = 1.73$ ($n = 45$ collections, 20-30 spores/collection)]; from two-spored basidia: 7.8-9.5 X 3.8-5 μm [$\bar{x}$ of $\bar{x} = 8.5$ X 4.5 μm ; $Q = 1.64$ -2.24, $\bar{x}Q = 1.88$]; ellipsoid or lacrymoid, with a prominent hilar appendage, smooth, hyaline, inamyloid, acyanophilous, white in deposit. BASIDIA 16.2-24.7 X 5-7.2 μm , clavate, hyaline, inamyloid, two- or four-sterigmate. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA abundant, (18)22.5-45(49.5) X (4.5) 6.3-13.5(18) μm , hyaline, inamyloid, thin-walled, often collapsed or gelatinized in age, of two types (both of which may be present): 1) subcylindric, clavate to sphaeropedunculate, obtuse and entire, 2) irregularly cylindric, contorted, often strangulate and lobed. Hyphae of immature



Fig. 1. Basidiocarps of Collybia bakerensis on inner bark of Abies, Halling 4385. x2.

PILEUS SURFACE suberect to erect, often interwoven; terminal cells 27-49.5 X 4.5-11.7 μm , subcylindric to clavate, inamyloid, thin-walled; hyphae of mature PILEUS SURFACE undifferentiated from tramal hyphae, but with a few, scattered, suberect or erect elements 39.6-74 X 6.7-15.8 μm ; cells subcylindric, clavate or ventricose-capitate, arising from filamentous, repent, nearly radially arranged, non-inflated or slightly inflated, non-diverticulate, hyaline, inamyloid, thin-walled hyphae, 4-11.7 μm in diam. PILEUS TRAMAL HYPHAE interwoven, poorly reviving, 4.5-13.5 μm in diam. LAMELLAR TRAMAL HYPHAE subparallel, 3.6-12(16) μm in diam, not gelatinous, hyaline, inamyloid, thin-walled. SUBHYMENIUM ramose, weakly gelatinized. STIPE TRAMAL HYPHAE parallel to subparallel, 3.4-11.3 μm in diam, hyaline, inamyloid, thin-walled. CAULOCYSTIDIA clustered, common near stipe apex, 29.7-47.5 X 8.1-14.8 μm , cylindric, clavate or rarely sphaeropedunculate, seldom contorted and lobed, hyaline, inamyloid, thin-walled. CLAMP CONNECTIONS abundant, but not at every septum.

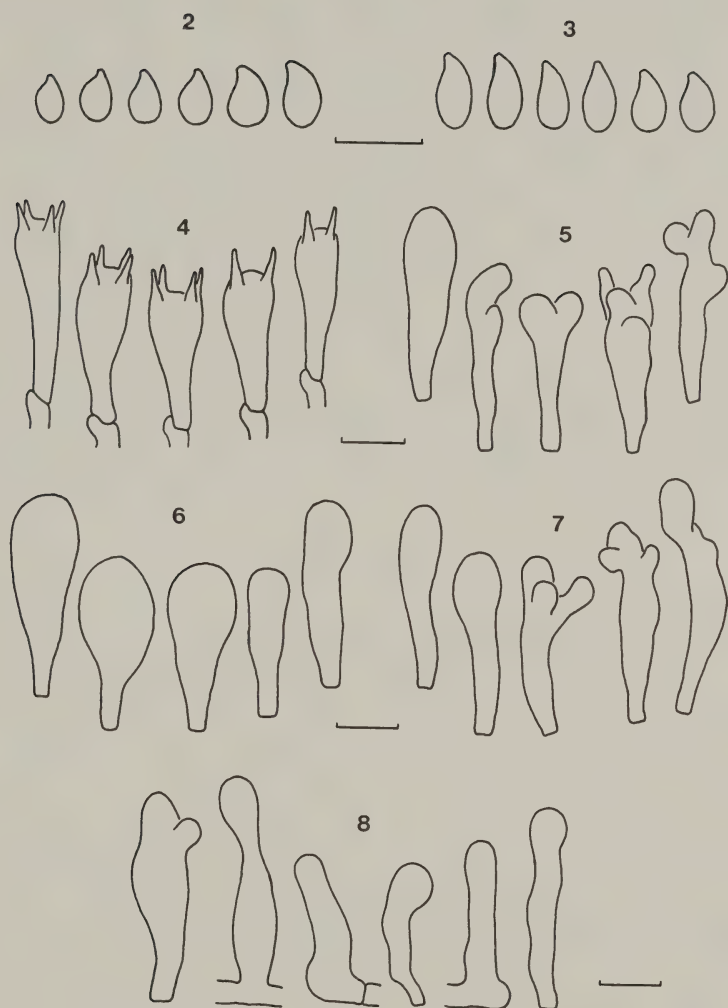
HABIT, HABITAT, AND DISTRIBUTION: Scattered to gregarious on fallen conifer logs. In California, typically on bark of *Abies*, soon after snow melt (May-July) above 2500 m in the Sierra Nevada and Cascade mountain ranges. In Colorado, Idaho, and Washington, typically on *Tsuga* (rarely *Picea*), July-October.

SPECIMENS EXAMINED: CANADA. British Columbia. Mt. Revelstoke National Park, Woolsey Creek, 23 Sep 1980, Redhead 3995 (DAOM 198929). UNITED STATES. California. ALPINE CO.: Hwy 4, E of Alpine Lake, 30 May 1966, Thiers 16387. AMADOR CO.: Silver Lake, 10 Jun 1966, Thiers 16944; 9 Jul 1982, Thiers 44644; Hwy 88 near Silver Lake, 6 Jul 1966, Thiers 17252; 10 Jul 1967, Thiers 20028. CALAVERAS CO.: Hwy 4, Big Meadow Campground, 29 May 1966, Thiers 16822. FRESNO CO.: Shaver Lake, 7 Jun 1967, Thiers 19411. LASSEN CO.: Lassen Volcanic National Park, Summit Campground, 29 Jun 1965, Thiers 12826; Juniper Lake, 30 Jun 1965, Thiers 12864. MARIPOSA CO.: Yosemite National Park, Big Oak Flat Rd, 19 Jun 1967, Thiers 19658; Glacier Point Rd, 20 Jun 1967, Thiers 19740. SHASTA CO.: Dead Horse Summit, 2 Jul 1982, Thiers 44601. SIERRA CO.: Sattley, 12 Jun 1982, Desjardin 1385 (dupl. in NY); Hwy 49, Yuba Pass, 15 Jun 1983, Desjardin 2078; 12 Jun 1984, Desjardin 2908; 6 Jul 1967, Thiers 19981; 27 May 1970, Thiers 25359; 28 Jul 1971, Thiers 27527; 10 Jun 1982, Thiers 44398; 11 Jun 1982, Thiers 44405; 7 Jun 1986, Halling 4670 (NY); 10 Jun 1986, Halling 4697 (NY); Sierra Nevada Field Camp, 11 Jun 1983, Desjardin 2086; 10 Jun 1985, Desjardin 3375, Halling 4385 (NY); Chapman Creek Campground, 2 Jun 1980, Thiers 40889. SISKIYOU CO.: Mt. Shasta, Sandflats Campground, 2 Oct 1983, Desjardin 2252; Panther Meadows, 5 Jul 1965, Kowalski 1774; 1 Jul 1982, Thiers 44574; near Callahan, Carter's Meadow, 1 Oct 1983, Desjardin 2265; Hwy 89, near McCloud, 15 Jun 1967, Thiers 19602. TEHAMA CO.: ±8 mi S of Lassen Volcanic National Park, 2 Jul 1982, Thiers 44165. TUOLUMNE CO.: Dodge Ridge Ski Area, 30 Jun 1966, Thiers 17189; Hwy 108, Clark Fork, 27 Jun 1967, Thiers 19860; near Bumblebee, 28 Jun 1967, Thiers 19939; Pinecrest, 22 May 1970, Thiers 25338. Colorado. SAN JUAN CO.: San Juan Mts, Trout Lake, 25 Aug 1956, A. H. Smith 52798 (MICH). Idaho. BONNER CO.: Granite Creek, 29 Sep 1943, Slipp 129 (MICH); 7 Jul 1964, A. H. Smith 68250 (MICH); Upper Priest Lake, 13 Oct 1966, A. H. Smith 74172 (MICH). VALLEY CO.: McCall, Brundage Mt, 2 Oct 1964, A. H. Smith 68821 (MICH). Washington. GRAYS HARBOR CO.: Enchanted Valley, Quinalt River, 2 Oct 1969, J. Williams 503 (WTU). PIERCE CO.: Mt. Rainier National Park, Wonderland Trail, Longmire, 11 Jul 1948, Simmons 1436 (MICH); Eagle Peak Trail, 15 Aug 1948, A. H. Smith 30126 (MICH); Powerhouse Area, 16 Sep 1954, A. H. Smith 47602 (MICH). SKAGIT CO.: Glacier Peak Wilderness, Found Lake, 17 Sep 1972, J. Williams (WTU). WHATCOM CO.: Panther Creek, 25 Jun 1971, J. Williams 1117 (WTU). All collections deposited in SFSU except where noted otherwise.

Diagnostic characters for *Collybia bakerensis* include:

a) a white, convex pileus, b) relatively narrow, close, white lamellae, c) a small, white, hysterochroic, sub- to non-insititious stipe, d) a tendency for basidiocarps to blush incarnate in age, and e) abundant, versiform cheilocystidia which range from broadly clavate to irregularly cylindric-contorted.

Initial comparison of the California material with the holotype specimen showed subtle but consistent differences in basidiocarp size, lamellar width, basidiospore width and cheilocystidial morphology. Although a concerted effort was



Figs. 2-8. Microscopic features of *Collybia bakerensis*. 2,3. Basidiospores (2. Holotype, Smith 16278; 3. Desjardin 3375). 4. Basidia (Desjardin 3375). Figs. 5-7. Cheilocystidia (5. Smith 16278; 6. Desjardin 2078; 7. Desjardin 3375). Fig. 8. Caulocystidia (Smith 16278). Scale bars = 10 μ m.

made to divide *C. bakerensis* into several varieties based on these observations, we are now convinced that these differences represent extremes in a morphological continuum. The holotype specimen represents one end of the continuum, characterized by pilei up to 40 mm broad, with narrow, crowded, subdecurrent lamellae, basidiospores with an average Q value of 1.47 (range 1.19-1.81) and irregularly cylindric, contorted and lobed cheilocystidia. In addition, basidiocarps develop in the autumn, typically on decayed *Tsuga* logs. At the other extreme are the California specimens, collected in the spring on *Abies* logs near melting snowbanks. These specimens are characterized by pilei typically less than 20 mm broad with close, moderately broad, adnate lamellae, basidiospores with an average Q value of 1.84 (1.72-2.0) and cheilocystidia that are generally broadly clavate to sphaeropedunculate and only rarely contorted and lobed. Spanning these extremes are collections from Idaho and Washington which combine features of both. One specimen in particular (A. H. Smith 47602) is demonstrative of the high degree of variability achieved by *C. bakerensis*. This specimen comprises approximately 40 basidiocarps collected in September from decaying *Tsuga* logs in Mt. Rainier National Park. Small basidiocarps display the features characteristic of Californian material, while larger ones are more like the holotype, and intermediate-sized basidiocarps display various aspects of both extremes.

Undoubtedly, the range of variation presented here is likely to be greater because of the large number of specimens at our disposal for examination. Therefore, some of our observations differ from those noted by earlier authors. There appears to be no correlation, for example, between basidiocarp age and cheilocystidia morphology as implied by Smith (1944). Some immature basidiocarps possess cheilocystidia that are exclusively cylindric-contorted and lobed, while the lamellar edges of other immature basidiocarps may have either contorted and lobed or broadly clavate cheilocystidia or both in varying numbers and ratios.

The faint yellow-staining reaction of the pileus and lamellae in Washington collections (Smith, 1944; Williams, 1974; Smith's field notes in MICH) was not observed on vernal California material. However, there is a tendency for overly mature basidiocarps to discolor sordid yellowish, a coloration also present in dried material.

Smith (1944) suggested that *C. bakerensis* was closely related to *C. maculata* (A. & S.:Fr.) Kummer, and possibly might be a variety of *C. xylophila* (Weinm.) Sacc. The

pinkish, dextrinoid and cyanophilous basidiospores of *C. maculata* are features of subgenus *Rhodocollybia* section *Maculatae* Lennox ex Halling (*fide* Halling, 1983). Therefore, *C. bakerensis* belongs in subgenus *Collybia* because of its white, inamyloid, acyanophilous basidiospores. In addition, radially arranged, non-diverticulate pileus surface hyphae indicate section *Vestipedes* (Fr.) Quélet. A modern description and unequivocal concept of *C. xylophila* seems to be lacking. The illustration by Fries (1873) depicts a cespitose, lignicolous, reddish-brown agaric with the stature of subgenus *Rhodocollybia*, and Cooke (1881-83) showed solitary or subcespitose basidiocarps with yellowish-brown tones, "...about old stumps...." Alternatively, Massee (1893) noted the discrepancy between the Fries and Cooke illustrations, but described a large *Collybia* quite like *C. luxurians* Pk. The descriptions of W. G. Smith (1908) and Rea (1922) parallel that of Massee. Whether or not *C. xylophila* and *C. luxurians* are synonymous is open to question, but the latter is certainly not conspecific with *C. bakerensis* [compare our Fig. 1 with Halling's (1983) Fig. 111].

ACKNOWLEDGEMENTS

We thank Dr. H. D. Thiers for supplying us with notes, collections, and for suggesting "*bakerensis*" as an epithet. We are also grateful to Drs. J. Ammirati (WTU) and R. L. Shaffer (MICH) for the loan of specimens, and Donald Black for his photographic expertise. For helpful comments, we are indebted to Drs. H. D. Thiers and R. H. Petersen.

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THE PLACEMENT OF PEZIZA EDULIS IN RICKIELLA
(SARCOSCYPHACEAE, PEZIZALES)

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ABSTRACT

Peziza edulis is shown to be an older name for Rickiella transiens. The combination Rickiella edulis is proposed and the monotypic genus Rickiella is briefly discussed.

Key words: Rickiella, R. edulis, Sarcoscyphaceae.

Peziza edulis Speg. was published in 1891 based on collections by Benjamin Balansa made in Paraguay in 1880. Specimens were distributed by Balansa in a series titled **Plantes du Paraguay**. Many of the collections in the sets did not have names when issued but the material was studied by Spegazzini (1883-1891) and written about in a series of articles titled **Fungi Guaranitici**. He named Balansa's number 3344 Peziza edulis. Isotypes of number 3344 of the **Plantes du Paraguay** were examined at the Farlow Herbarium and at the Royal Botanic Gardens, Kew. The material is a curious Discomycete which has a flat, smooth hymenium and excipular tissues which are run through by cavities and chambers creating a spongy, honeycombed apothecium. Study of the material shows that it is identical to Rickiella transiens Sydow in Rick.

Rickiella Sydow in Rick, a monotypic genus, has been considered by Korf (1973) to be close to Phillipsia. It differs from the larger species of Phillipsia in the presence of regularly chambered sterile apothecial tissues. A number of collections have been examined and in all the pattern of chambering is very similar. In Peziza edulis the ascospores are smooth; the common species of Phillipsia have longitudinally striate

ascospores but several Phillipsia species do have smooth ascospores. Other than in the lacunose, spongy excipular tissues, the excipular anatomy in Peziza edulis is very much like that found in Phillipsia. With the finding that Peziza edulis is the older name for Rickiella transiens, the proper combination in Rickiella can now be made and a full description provided.

Rifai (1968) pointed out that there are several series which can be recognized in Phillipsia. Studies on Phillipsia and the relationships of its species are needed to determine whether Rickiella should indeed be merged with Phillipsia. Lloyd (1923) thought that the genus Rickiella was so distinct that it was safe from any name juggling.

Rickiella edulis (Speg.) D. H. Pfister, comb. nov.

= Peziza edulis Speg., Rev. Argentina Hist. Nat. 1: 422. 1891.

= Rickiella transiens Sydow in Rick, Ann. Mycol. 2: 244. 1904.

Apothecia up to 3 cm in diam, short stalked or pulvinate, hymenium yellowish to orangish, receptacle buff, lacunose and chambered. Subhymenium an indistinct layer of tightly woven textura intricata. Excipulum run through by canals to give a honeycombed appearance. The smaller cavities are loosely filled with hyphae; the larger ones are completely empty. Many of the cavities are open to the outer surface. Medullary excipulum of textura intricata 5-6 um in diam. Ectal excipulum an indistinct layer about 50 um thick composed of textura porrecta, the outer cells of which diverge to produce a poorly developed tomentose layer. The hyphae producing the tomentose layer are 3-5 um in diam, blunt at the apex and up to 60 um long; they are sometimes intertangled. Asci 350-400 x 18-22 um tapering into a long, thin base. Ascospores hyaline, ellipsoid, sometimes slightly asymmetrical, biguttulate, 20-24 x 11-13 um, smooth. Paraphyses straight, branched only near the base and unexpanded at the apex, septate, 3-4 um wide.

On fallen branches.

In Paraguay and Brazil.

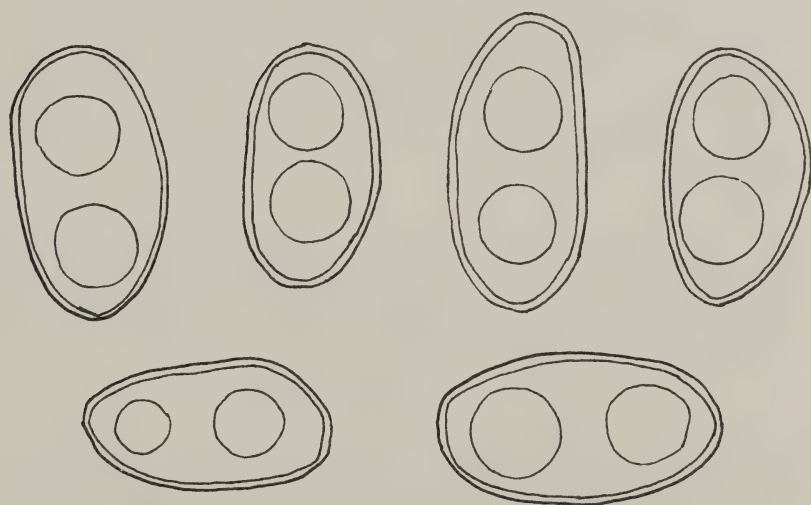
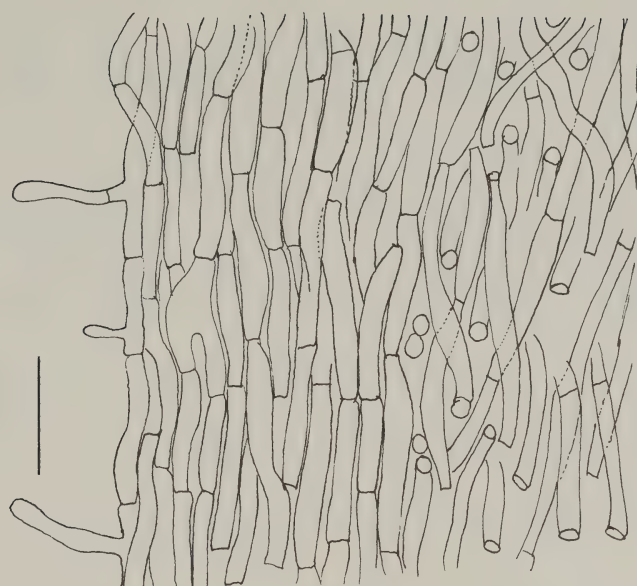


Figure 1. *Rickiella edulis* from Balansa, Plantes du Paraguay no. 3344 (FH).

Top. Ascospores. Scale = 20 μ m.

Bottom. A portion of the excipulum. Scale = 20 μ m.

Specimens examined. Paraguay: ISOTYPES of Peziza edulis. Balansa, Pl. du Paraguay -- 1878-1884, no. 3344. Guarapi; sur la terre, dans les forets. 1880. (FH and K). Brazil: Four collections from Serro Azul, Rio Grande do Sul. 1928 collected by Rick and identified as Rickiella transiens (FH). Two collections from Sao Leopoldo, 1905, Rick (BPI). Two collections in the Lloyd 28302, 15117 (BPI). Sta Cruz, Rio Grande do Sul, col. Rick, 1922 (Herb. J. R. Weir no. 20738, BPI). Also issued by Rick in Fungi Austro-Americani Exsiccati, no. 2, as Rickiella transiens (FH, BPI). [Initially this specimen was labeled Leopoldina transiens but this genus, a nomen nudum, was struck out by Rick and Rickiella was written in by hand.]

Note: Specimens of Peziza edulis were encountered during examinations of Peziza type specimens. I have not located detailed accounts of the species' edibility but Spegazzini did write that it was edible.

Rickiella was compared with Cyttaria when it was first described. This was apparently because of the spongy appearance of both. In Cyttaria the cavities, which give the spongy appearance, contain the hymenia; in Rickiella edulis the cavities are formed in the sterile tissues of the apothecium. Cyttaria is now treated as a separate family and order - the Cyttariaceae and the Cyttariales. Lloyd (1918) suggested that the genus was close to Rhizina. Rick reconsidered his initial placement of the genus when he later listed Rickiella among the Rhizinaceae (Rick, 1931).

This work was supported by NSF grant DEB 80-23018 and by a grant from the Whiting Foundation. I wish to thank the Director of the Royal Botanic Garden, Kew for access to the collections there and Dr. Amy Y. Rossman for access to the USDA collections (BPI).

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MATERIALS FOR A LICHEN FLORA OF THE ANDAMAN ISLANDS-V

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ABSTRACT

Sixteen species of Thelotremales from the Andaman Islands, India are described and illustrated. Leptotrema submicrosporoides and Thelotrema subexpallesens are new species. Ocellularia platystoma and O. turgidula are new records to the lichen flora of India. The rest, except Thelotrema rugatulum, are recorded for the first time from the Andaman Islands.

This paper, fifth in the series of on-going studies of the lichens from the Andaman Islands, gives an account of sixteen species of Thelotremales. Distribution records outside of the Islands are taken from Hale (1974, 1978, 1981), from our own identified materials in AMH and from examination of types.

Leptotrema epitrypum (Nyl.) A.L. Sm., J. Linn. Soc. London 46:74 (1922). (Fig.1)
Thelotrema epitrypum Nyl., Acta Soc. Sci. Fenn. 7:454 (1863).

Thallus greenish gray, rugulose, epiphloeodal, cortex 8-10 µm thick, medulla 30-50 µm thick, with crystals; ascocarps numerous, solitary, closely disposed, emergent, ± constricted at the base, 0.8-1.5 mm diam, columellate; pore gaping, 300-700 µm across; thalline rim suberect, exciple carbonized; columella branched, 3-4 strands, pruinose at the tip, carbonized; hymenium 150-180 µm high; ascospores 8 per ascus, brown, muriform, 8-10 x 10-15 µm, 1-2 x 3-4 loculate, I-.

Chemistry : Psoromic acid.

Specimens examined : South Andaman, Alexandria Island - 85.1109, 1140.

Distribution : West Indies, India, Sri Lanka, Philippines.

Leptotrema fissum (Nyl.) Müll.Arg. and L. crassum Müll.Arg. are the closest species in the genus to L. epitrypum in respect to the branched columella, small (less than 20 µm long) ascospores and psoromic acid. However, they have a thicker (more than 25 µm thick) cortex. Furthermore, L. fissum has ascocarps distinctly emergent, constricted at the base.

The isotype of Leptotrema epitrypum (Lindig 2796-isotype in UPS!) has thin (8-10 µm) cortex and simple to perfectly branched columella.

Leptotrema monosporum (Nyl.) Müll.Arg., Bull. Soc. r. Bot. Belg. 31:35 (1892). (Fig.2)

Thelotrema monosporum Nyl. Annls Sci. nat. (Bot.) IV 15:46 (1860).

Thallus olivaceous buff, smooth, hypophloeodal, ecorticate, medulla 30-40 µm thick; ascocarps many, solitary, emergent, 0.6-0.9 mm diam; disc 300-400 µm across, white pruinose; thalline rim entire, suberect, exciple free, pulling away from the thalline wall with the disc, with periphysoids; hymenium 100-120 µm high; ascospores 2-4 per ascus, brown, muriform, 15-20 x 45-65 µm, I-.

Chemistry : Lacking lichen substances.

Specimens examined : South Andaman, Baratang Island, Wrafter's creek- 85.628b; North Andaman, Tugapur Range, Pathar Tikri- 85.2615, Mayabandar Range, Interview Island- 85.2925.

Distribution : Sri Lanka, India, New Caledonia.

Leptotrema monosporum, L. hawaiiense Hale, Thelotrema lepadinum (Ach.) Ach., Phaeotrema lacteum (Krempelh.) Müll.Arg. and P. rockii A. Zahlbr. constitute a group with emergent ascocarps, periphysoid-bearing exciple and non-corticate thallus. T. lepadinum has hyaline, muriform ascospores whereas P. lacteum and P. rockii have brown, transversely septate ascospores. L. hawaiiense, the only comparable species, has stictic and constictic acids.

Leptotrema submicrosporoides, sp. nov.

(Fig.3)

Thallus corticola, olivaceo-bubalinus, laevis, hypophloeodes; ascocarpia numerosa, solitaria, semi-emergentia vel emergentia, 0.4-0.6 mm diametro, columellata; ostiolum rotundatum, sat apertum, 200-250 µm diametro, minute fuligineo circumcirco; excipulum carbonaceum; columella cylindrica, 120-180 µm crassa, carbonacea; hymenium 80-100 µm altum; ascosporae 8 :nae, fuscae, murales, 4-6 x 10-13 µm, 1-2 x 4 loculatae, I-.

Thallus olivaceous buff, smooth, hypophloeodal, cortex 3-5 µm thick, medulla 50-80 µm thick, with crystals; ascocarps numerous, solitary, semi-emergent to emergent, 0.4-0.6 mm diam, columellate; pore round, moderately open, 200-250 µm across, thin black rimmed; exciple carbonized; columella simple, 120-180 µm thick, filling the pore, carbonized; hymenium 80-100 µm high; ascospores 8 per ascus, brown, muriform, 4-6 x 10-13 µm, 1-2 x 4 loculate, I-.

Chemistry : Lacking lichen substances.

Typus : India, Andaman Islands, South Andaman, Tarmuguli Island, 19th December 1985, P.K. SETHY & M.B. NAGARKAR 85. 1975, Holotype -AMH, Isotype-US.

This columellate species is very unique, among the species having small (less than 15 µm long) ascospores, in lacking any lichen substances. Leptotrema microsporoides A. Zahlbr., a very closely related species with similar black-rimmed pore and ascospore size, has immersed ascocarps, simple to branched columella and lichexanthone in the thallus.

Ocellularia groenhartii Hale, Mycotaxon 3(1):173 (1975).

(Fig.4)

Thallus greenish gray to olivaceous buff, smooth, shiny, partly hypophloeodal, cortex 12-18 µm thick, medulla 150-180 µm thick, with crystals; ascocarps many, solitary, emergent, 0.8-1.2 mm diam, columellate; pore round, moderately open, 250-400 µm across; exciple carbonized in the later stage; columella simple, distinct, 200-300 µm thick, partially filling the pore, white pruinose tip, carbonized; hymenium 250-320 µm high; ascospores 4-8 per ascus, hyaline, transversely septate, 10-15 x 80-125 µm, 15-22 loculate, I + violet.

Chemistry : 'Chonestoma' and 'Olivacea' unknowns.

Specimens examined : South Andaman, Tarmuguli Island - 85.1857; North Andaman, Mayabandar Range, Kaichi Nala - 85.2748.

Distribution : Java, India, Guadalcanal, Solomon Islands.

This species is very closely allied to Ocellularia allosporoides (Nyl.) Patw. & Kulk., which has more or less similar morphology and anatomy. However, O. allosporoides lacks lichen substances.

Ocellularia kamatii Patwardhan & Kulkarni, Norw. J. Bot. **24**:130 (1977).
(Fig.5)

Thallus greenish gray to olivaceous buff, cracked, hypophloeodal, cortex indistinct, medulla 50-80 μ m thick, with dense crystals; ascocarps numerous, solitary to in a group of two, immersed to slightly raised, 0.3-0.5 mm diam, eolumellate; pore gaping, moderately open, 100-150 μ m across; thalline rim entire to cracked, exciple free forming a pore-within-a-pore configuration, with periphysoids, non-carbonized; hymenium 90-120 μ m high; ascospores 4 per ascus, hyaline, transversely septate, 20-25 x 60-100 μ m, 20-25 loculate, I + violet.

Chemistry : Lacking lichen substances.

Specimen examined : Little Andaman, Buttler Bay - 85.932.

Distribution : India, Sri Lanka.

Ocellularia kamatii, which is a member of 'O. subtilis' complex with non-carbonized, periphysoid-bearing exciple and lacking lichen substances, is distinguished by the frequently grouped (2 to 3), more or less immersed ascocarps and large (more than 80 μ m long) ascospores. The comparable species among the group having large ascospores are O. pseudoexanthismocarpa Patw. & Kulk. which has erect to nearly recurved, apically eroded appearing white coarse thalline rim and O. nureliya (Hale) Patw. et al. which has solitary ascocarps, entire thalline rim and grows at higher (850-2100 m) elevations.

This is one of the few species collected so far in India and Sri Lanka only.

Ocellularia papillata (Leighton) A. Zahlbr., Cat. Lich. Univ. **2**:597 (1924).
(Fig.6)

Thelotrema papillatum Leighton, Trans. Linn. Soc. London **25**:169 (1869).

Thallus greenish gray to olivaceous buff, smooth, partly hypophloeodal, cortex 10-15 μ m thick, medulla 60-90 μ m thick; ascocarps many, solitary, immersed to slightly raised, 0.4-0.6 mm diam, columellate; pore round, moderately open, 120-150 μ m across, white rimmed; exciple carbonized in the ostiolar region or little below; columella simple, weakly developed to distinct, 50-180 μ m thick, weakly carbonized to distinct; hymenium 100-150 μ m high; ascospores 8 per ascus, hyaline, transversely septate, 4-6 x 16-27 μ m, 6-8 loculate, I + violet.

Chemistry : Lacking lichen substances.

Specimens examined : South Andaman, Baratang Island, Wrafter's creek-85.567, 568, 569, 571, 582; North Andaman, Diglipur Range, Kalara-86.386, 387, Milangram-86.252, 253, 255, 279, 280, 365.

Distribution : Sri Lanka, India, Philippines, West Indies, Panama, Dominica, New Caledonia.

Ocellularia papillata, O. perforata (Leighton) Müll.Arg. and O. diacida Hale are very close in having a weakly-developed columella, carbonization restricted to the apices of the exciple and columella, and small (20-35 μ m long) ascospores. However, O. perforata has protocetraric acid; O. diacida has 'diacida' unknown in the thallus and both lack a white-rimmed pore which is present in O. papillata.

Ocellularia platystoma (Mont.) A. Zahlbr., Cat. Lich. Univ. **2**:598 (1924).
(Fig.7)

Thelotrema platystoma Mont., Ann. Sci. Nat. Bot., Ser. 2, **15**:79 (1843).

Thallus pale buff to straw coloured, smooth, hypophloeodal, cortex indistinct, medulla 20-30 μ m thick; ascocarps numerous, solitary, semi-emergent,

0.6-0.8 mm diam, columellate; pore round, open, 300-400 μ m across, black rimmed; exciple carbonized; columella simple, broad, 300-400 μ m thick, filling the pore, carbonized; hymenium 100-200 μ m high; ascospores 8 per ascus, hyaline, transversely septate, 5 x 12-15 μ m, 5-6 loculate, I + violet.

Chemistry : Lacking lichen substances.

Specimens examined : North Andaman, Mayabandar Range, Kaichi Nala- 85.2745, 85.2752.

Distribution : India, Sri Lanka, French Guiana.

Ocellularia discoidea (Ach.) Müll.Arg., the only comparable species in the genus has more emergent ascocarps and psoromic acid in the thallus.

Ocellularia terebrata (Ach.) Müll.Arg., Mém. Soc. Phys. Hist. Nat. Genève 29(8):7 (1887). (Fig.8)

Thelotrema terebratum Ach., Kongl. Vetensk. Acad. Nya Handl. p. 88 (1812).

Thallus greenish gray, smooth to uneven, epiphloeodal, cortex 12-16 μ m thick, medulla 120-150 μ m thick, with crystals; ascocarps many, solitary, immersed, 0.2-0.4 mm diam, columellate; pore round, minute, 50-80 μ m across; exciple carbonized; columella simple, weakly developed, 30-50 μ m thick, brown to dark brown; hymenium 100-130 μ m high; ascospores 8 per ascus, hyaline, transversely septate, 5-7 x 20-25 μ m, 6-8 loculate, I + violet.

Chemistry : Psoromic acid.

Specimen examined : Middle Andaman, Betapur Range, Pitcher Nala- 85.2350.

Distribution : Brazil, India.

Ocellularia garoana Patw. & Nagarkar, a most closely related psoromic acid containing species, differs from O. terebrata in having semi-emergent ascocarps, more well-developed columella and consistently somewhat smaller (14-19 μ m long) ascospores.

The other closest relatives, O. papillata (Leighton) A. Zahlbr. and O. perforata (Leighton) Müll.Arg., have the same gross morphology and anatomy but lack psoromic acid.

Ocellularia turgidula Müll.Arg. in J. Bot. 7:7 (1893).

(Fig.9)

Thallus whitish gray to greenish glaucous, smooth to minutely verruculose, mostly hypophloeodal, cortex indistinct, medulla 30-50 μ m thick, with crystals; ascocarps numerous, closely disposed, $\pm$ immersed, 0.3-0.45 mm diam, eolumellate; pore round, moderately open, 100-150 μ m across; thalline rim entire, exciple free, with periphysoids, non-carbonized; hymenium 100-130 μ m high; ascospores 4-8 per ascus, 10-12 x 60-80 (95) μ m, 16-18 loculate, I + violet.

Chemistry : Lacking lichen substances.

Specimens examined : South Andaman, Tarmuguli Island- 85.1925, 1929.

Distribution : Panama, Japan, India, New Caledonia.

Ocellularia turgidula has morphology and chemistry comparable to O. nureliya (Hale) Patw. et al. However, O. nureliya has somewhat larger (more than 100 μ m long) ascospores and seems to be restricted to a higher (850-2100 m) elevation.

Thelotrema annuloelevatum Nagarkar, Sethy & Patwardhan, Kavaka (in press). (Fig.10)

Thallus smoke gray to ashy gray, minutely warty, mostly hypophloeodal, cortex 10-12 μ m thick, medulla 40-60 μ m thick; ascocarps many, solitary,

emergent, 0.8-1.2 mm diam, eolumellate; pore round, moderately open, 200-300 μ m across, depressed, slightly elevated rim around the pore; exciple fused, carbonized; hymenium 350-450 μ m high; ascospores 1-2 per ascus, 30-40 x 130-160 μ m high, I + deep violet.

Chemistry : Psoromic acid.

Specimens examined : South Andaman, Baratang Island, Baludera- 85.722, 730, 732, 733, 746, 767, 788, 828, 833, 844.

Distribution : India.

The main feature of this species is the conspicuous, raised, thick annulate rim, although this varies and is not well-developed in the present specimens from Baludera of Baratang Island, but have eolumellate ascocarps, carbonized exciple, large ascospores and psoromic acid in the thallus.

Thelotrema arecae Vainio, Hedwigia 46:174 (1907).

(Fig.11)

Thallus pale buff, rough, partly hypophloeodal, cortex 6-8 μ m thick, medulla 30-50 μ m thick; ascocarps many, solitary, strongly emergent, constricted at the base, ascidioid, 1-1.5 mm diam, columellate; pore moderately open, slightly depressed, rarely thin dark area, 200-400 μ m across; exciple carbonized; columella simple, 120-200 μ m thick, filling the pore, carbonized; hymenium 200-300 μ m high; ascospores 1 per ascus, 25-32 x 120-160 μ m, I + deep violet.

Chemistry : Hypoprotocetraric acid and an unknown spot below hypoprotocetraric.

Specimens examined : South Andaman, Baratang Island, Baludera- 85.812, 842.

Distribution : India, Philippines.

The conspicuous, strongly emergent, columellate ascocarps, depressed pore, and presence of hypoprotocetraric acid characterize this species.

This species seems to be restricted in Asia only and occurs mostly in open primary forests.

Thelotrema asiaticum Vainio, Hedwigia 46:175 (1907).

(Fig.12)

Thallus greenish gray, smooth, epiphloeodal, cortex 20-30 μ m thick, medulla 80-100 μ m thick; ascocarps many, solitary, semiemergent to emergent, 0.6-0.8 mm diam, columellate; pore moderately open, 200-350 μ m across; exciple carbonized; columella simple, broad, 150-330 μ m across, carbonized; hymenium 80-100 μ m high; ascospores 8 per ascus, hyaline, muriform, 5-7.5 x 15-20 μ m, 2 x 5-6 loculate, I + violet.

Chemistry : Psoromic acid.

Specimens examined : North Andaman, Tugapur Range, Pathar Tikri- 85.2610, 2630.

Distribution : India, Siam.

Thelotrema asiaticum and T. leucinum Müll.Arg. are the closest species in respect to the broadly columellate ascocarps, small (less than 20 μ m long) ascospores and psoromic acid in the thallus. However, T. leucinum has somewhat less emergent ascocarps and more opened (500-1200 μ m diam) pore.

Thelotrema masonhalei Patwardhan and Kulkarni, Norw. J. Bot. 24:128 (1977).

(Fig.13)

Thallus pale buff to pale greenish gray, verruculose, hypophloeodal, cortex 8-10 μ m thick, medulla 25-35 μ m thick, with crystals; ascocarps inconspicuous, deeply immersed in the periderm, 0.6-0.9 mm diam, eolumellate;

pore round, minute, 30-60 μm across, off-white rimmed; exciple fused, reddish brown to dark brown; hymenium 200-400 μm high; ascospores 1 per ascus, 35-42 x 150-207 μm , I + deep violet.

Chemistry : Psoromic acid.

Specimens examined : South Andaman, Tarmuguli Island - 85.1875, 1876.

Distribution : India, Sri Lanka.

While examining the type from Amboli (Prabhu & Nagarkar 74.2262 holotype-AMH) and all other specimens belonging to this taxon from South India, we were able to detect weakly-developed columella but definitely present in the ascocarps. However, the columella being very weakly-developed and centrally situated, it is very difficult to trace out.

Though Andaman specimens are devoid of a columella, they appear to be identical otherwise with T. masonhalei. This is another one of the few species known so far in India and Sri Lanka.

Thelotrema rugatum Nyl., Bull. Soc. Linn. Normand. 7(2):168 (1873). (Fig.14)

Thallus off-white, smooth, partly hypophloeodal, cortex 5-8 μm thick, medulla 120-160 μm thick; ascocarps numerous, solitary, immersed, 0.4-0.5 mm diam, eolumellate; pore moderately open, depressed, 150-250 μm across, pore gaping; thalline rim entire to rarely crenate, exciple free, non-carbonized, ashy white pruinose at the upper part, with periphysoids; hymenium 200-250 μm high; ascospores 1-2 per ascus, hyaline, muriform, 15-20 x 80-120 μm , I-.

Chemistry : Lacking lichen substances.

Specimen examined : South Andaman, Tarmuguli Island - 85.1956.

Distribution : India.

Externally this species is identical with 'Ocellularia subtilis' group, especially with regards to the distinct inner exciple forming a kind of double pore with the main apothecial rim, however, has muriform ascospores.

This is the second report of the species since its description by Nylander (1873) from the Andaman Islands. This species seems to be restricted to India only.

Thelotrema subconforme Nyl., J. Linn. Soc. Bot. 20:53 (1883). (Fig.15)

Thallus greenish gray, smooth to uneven, epiphloeodal, cortex 20-30 μm thick, medulla 60-85 μm thick, with crystals; ascocarps numerous, solitary, immersed, 1.5-2.5 mm diam, eolumellate; pore round, 100-120 μm across, off-white area; exciple $\pm$ free, pale yellow, without periphysoids; hymenium 60-90 μm high; ascospores 8 per ascus, hyaline, muriform, 5-7 x 15-18 μm , 2 x 3-4 loculate, I + deep violet.

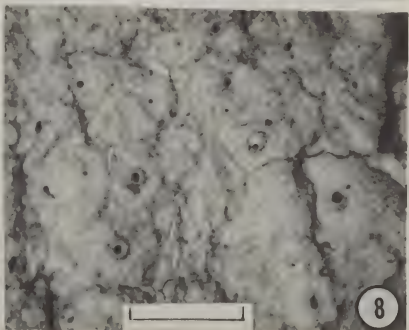
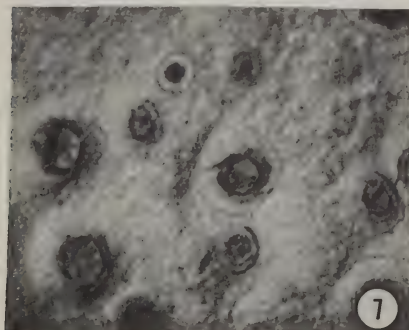
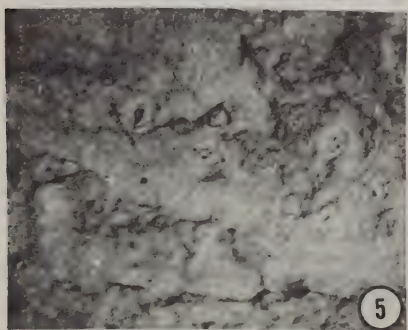
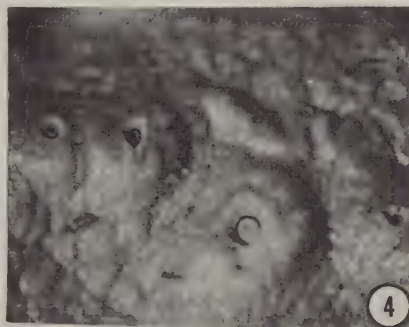
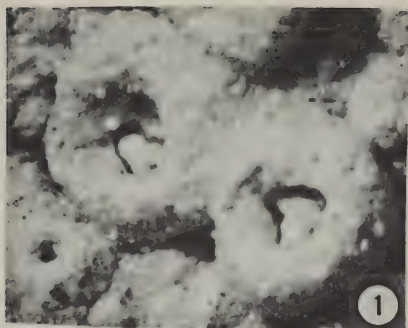
Chemistry : Lacking lichen substances.

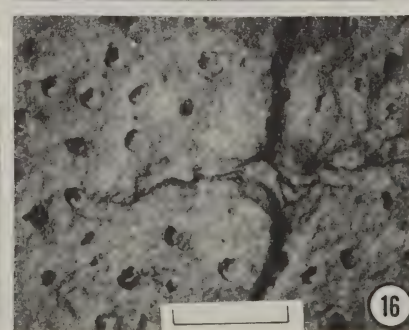
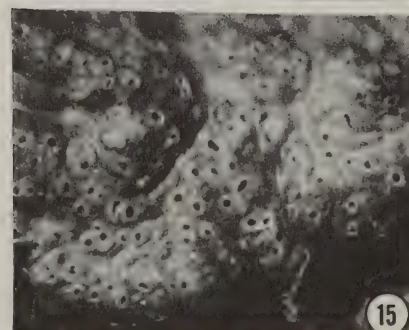
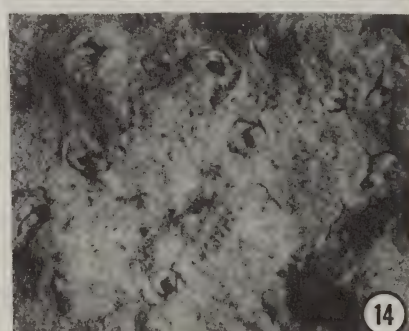
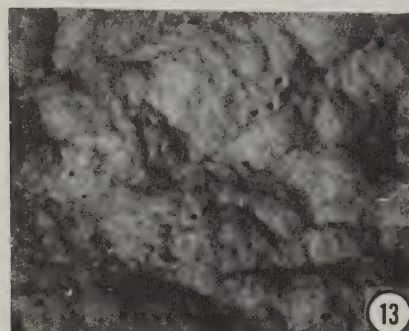
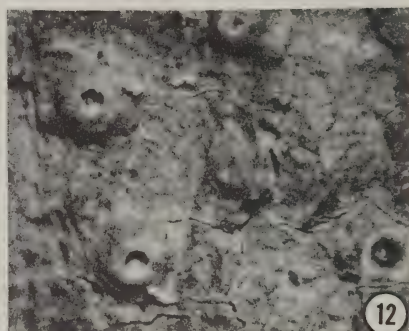
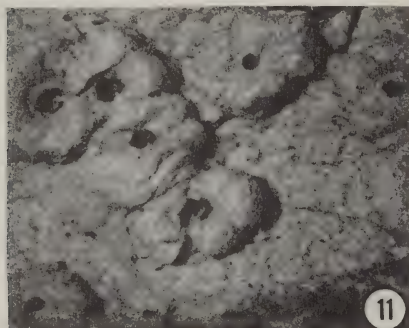
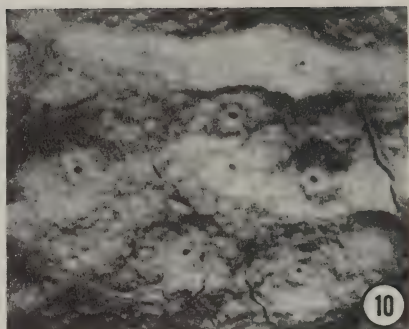
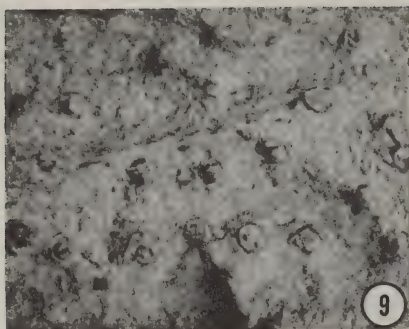
Specimens examined : South Andaman, Tarmuguli Island - 85.1858, 1859.

Distribution : India, Sri Lanka, Malaya, Philippines, Java, Sarawak, Solomon Islands.

This species closely resembles Ocellularia alba (Fée) Müll.Arg. in gross morphology, anatomy and chemistry, but has transversely septate ascospores.

Explanation of figures 1-16. 1. Leptotrema epitrypum (85.1109); 2. L. monosporum (85.2925); 3. L. submicrosporoides (85.1975, Holotype-AMH); 4. Ocellularia groenhartii (85.2748); 5. O. kamatii (85.932); 6. O. papillata (85.571); 7. O. platystoma (85.2745); 8. O. terebrata (85.2350); 9. O. turgidula (85.1925); 10. Thelotrema annuloelevatum (85.828); 11. T. arecae (85.812); 12. T. asiaticum (85.2630); 13. T. masonhalei (85.1875); 14. T. rugatum (85.1956); 15. T. subconforme (85.1858); 16. T. subexpallesces (85.2258, Holotype-AMH). Scale in mm.





Thelotrema subexpallescens, sp. nov.

(Fig.16)

Thallus corticola, fumosus vel viridi-griseus, laevis, hypophloeodes; ascaria numerosa, solitaria, immersa, 0.25-0.35 mm diametro, ecolumellata; ostiolum rotundatum, sat apertum, 120-200 μ m diametro; margine thallino integro vel lacerato, suberecto; excipulum liberum, non-carbonaceum, apice albo-pruinose, periphysoidibus instructis; hymenium 60-90 μ m altum; ascospores 8-nae, incolores, murales, 4-6 x 20-24 μ m, 2-3 x 8-10 loculatae, I-.

Thallus smoke gray to greenish gray, smooth, cracked with age, hypophloeodal, cortex indistinct, medulla 120-150 μ m thick; ascocarps numerous, solitary, immersed, 0.25-0.35 mm diam, ecolumellate; pore round, moderately open, 120-200 μ m across; thalline rim entire to crenate, suberect, exciple free, non-carbonized, ashy white pruinose in the upper region, with periphysoids; hymenium 60-90 μ m high; ascospores 8 per ascus, hyaline, muriform, 4-6 x 20-24 μ m, 2-3 x 8-10 loculate, I-.

Chemistry : Stictic acid.

Typus : India, Andaman Islands, Middle Andaman, Long-island Range, Parlobjig Island, 23rd December 1985, M.B. NAGARKAR & P.K. SETHY 85.2258, Holotype-AMH, Isotype-US.

The present species is closely allied to Thelotrema expallescens Nyl., a new world species, with a free, periphysoid-bearing exciple and stictic acid in the thallus, but T. expallescens has thick cortex and somewhat smaller (16 μ m long) ascospores.

ACKNOWLEDGEMENTS

We are highly thankful to Dr. Mason Hale, Smithsonian Institution, Washington, D.C., U.S.A. for critical review and valuable suggestions. We are also thankful to the Keepers/Curators of the Herbarium of TUR and UPS for the loan of specimens and to the Department of Science and Technology, New Delhi for financial support.

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New Combinations in *Fistulariella* (Ramalinaceae)

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Fistulariella confertula (Krog & Østh.) Bowler, **comb. nov.**
Basionym: *Ramalina confertula* Krog & Østh., Norw. Jour.
Bot. 27: 185. 1980.

Fistulariella deminuta (Krog & Østh.) Bowler, **comb. nov.**
Basionym: *Ramalina deminuta* Krog & Østh., Norw. Jour. Bot.
27: 271. 1980.

Fistulariella parva (Krog & Østh.) Bowler, **comb. nov.**
Basionym: *Ramalina parva* Krog & Østh., Norw. Jour. Bot.
25: 56. 1978.

As Krog and Østhagen note in their excellent discussion of *F. confertula*, the species is unique in the genus "in that most laciniae split open and flatten into irregularly strap-shaped branches with a non-corticate underside" (Krog and Østhagen, 1980a). This species is apparently endemic to the Madeira Islands and contains divaricatic and usnic acids. *Fistulariella deminuta* and *F. parva* are both characteristic of the genus and are well described by Krog and Østhagen (1980b). With these transfers, there are now thirty species in *Fistulariella* (Tables 1 and 2).

¹Bowler, P.A. and P.W. Rundel, 1977. Synopsis of a new lichen genus, *Fistulariella* Bowler & Rundel (Ramalinaceae). Mycotaxon VI: 195-292.

²Follman, G. and S. Huneck. 1968. Mitteilung uber Flechteninhaltsstoffe. LXI. Zur Chemotaxonomie der Flechtenfamilie Ramalinaceae. Willdenowia 5: 333-343.

- ³Hale, Mason E., Jr. 1979. How to Know the Lichens. Second Edition. Wm. C. Brown Publishers. Dubuque, Iowa.
- ⁴Krog, H. and H. Østhaugen. 1978. Three new *Ramalina* species from Macronesia. Norw. Jour. Bot. 25: 55-59.
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- ⁹Krog, H. and T.D.V. Swinscow. 1974. *Ramalina* species with a hollow thallus in (*Fistularia*) in East Africa. Norw. Jour. Bot. 21: 111-124.
- ¹⁰Krog, H. and T.D.V. Swinscow. 1976. The genus *Ramalina* in East Africa. Norw. Jour. Bot. 23: 153-175.

Table I. A summary of the chemistry, distribution, reproductive mode, substrate preference and selected references for *Fistulariella* species. Several of these species are known primarily from descriptions or early studies (for example, *F. tasmanica*, *F. javanica*, and *F. panizzei*) and type material of others has been discussed in treatments of other species (*F. fissa*, *F. intricata* and *F. turgida*).

Species (Reference)	Secondary Compounds	Soredia (S), Apical (G) Granules; Apothecia (A)	Substrate
<i>F. abyssinica</i> (9, 10)	Sekikaic acid aggregate	A	Corticolous
<i>F. almqvistii</i> sens. str. (1, 7)	Divaricatic acid or unidentified compound	A	Saxicolous
<i>F. almqvistii</i> terricolous morph (1, 7)	Divaricatic acid or unidentified compound		Terricolous
<i>F. calcarata</i> (9, 10)	Divaricatic acid & salazinic acid in the hymenium	A	Corticolous
<i>F. carpatica</i> (1)	Obtusatic acid (9)	A	Saxicolous
<i>F. confertula</i> (5)	Divaricatic acid		Saxicolous
<i>F. consanguinea</i> (9, 10)	Divaricatic & norstictic acids	A	Corticolous
<i>F. diminuta</i> (6)	Divaricatic & unidentified fatty acid	A	Saxicolous

Species (Reference)	Secondary Compounds	Soredia (S), Apical (G) Granules; Apothecia (A)	Substrate
<i>F. fimbriata</i> (9, 10)	Divaricatic acid	S	Saxicolous or Corticolous
<i>F. fissa</i> (9)	Salazinic acid	A	Corticolous
<i>F. geniculata</i> auct. (1)	Divaricatic acid ?	A	Corticolous
<i>F. inflata</i> sens. str. (9)	Divaricatic acid	A	Corticolous
<i>F. inflata</i> auct. (1, 3)	Divaricatic acid	A	Corticolous
<i>F. intricata</i> (9)	Divaricatic acid	A	Saxicolous
<i>F. javanica</i>	Not known		Not known
<i>F. minuscula</i> auct. (1, 3)	Divaricatic acid	A	Corticolous
<i>F. panizzei</i>	Not known	A	Corticolous
<i>F. parva</i> (4, 6)	Divaricatic acid		Saxicolous
<i>F. pitardii</i> (6)	Sekikaic & salazinic acids		Saxicolous
<i>F. pocsii</i> (10)	Sekikaic acid aggregate	A	Corticolous
<i>F. portuensis</i> (6, 8)	Salazinic & unknown compound	S	Corticolous, rarely saxicolous

Species (reference)	Secondary Compounds	Granules; Apothecia (A)	Substrate
<i>F. pumila</i> (9)	Divaricatic acid	A	Corticulous
<i>F. pusilla</i> (5, 6)	1. Sekikaic + salazinic acid 2. Salazinic acid	A	Corticulous, rarely saxicolous
<i>F. pusiola</i> (9, 10)	Sekikaic acid aggregate + trace norstictic in hymenium	A	Corticulous
<i>F. roesleri</i> (1, 3, 7, 10)	1. Divaricatic acid 2. sekikaic acid aggregate (7)	S	Corticulous
<i>F. scoparia</i> (1, 7)	Sekikaic acid aggregate	S	Saxicolous
<i>F. subgeniculata</i> (6, 9)	Divaricatic acid + trace norstictic + trace salazinic acids	A	Corticulous
<i>F. subpusilla</i> (6, 9, 10)	Salazinic acid	A	Corticulous
<i>F. tapperi</i> (9, 10)	Sekikaic acid aggregate	G	Saxicolous
<i>F. tasmanica</i>	not known		Corticulous
<i>F. translucida</i> (9, 10)	Unknown RI Divaricatic acid Sekikaic acid aggregate	A	Saxicolous or Corticulous
<i>F. turgida</i> (9)	Sekikaic acid aggregate	A	Terricolous

Table 2. A summary of the distribution of *Fistulariella* species.

Species	Distribution
<i>F. abyssinica</i>	East Africa
<i>F. almquistii sens. str.</i>	Beringian in North America
<i>F. almquistii terricolous morph</i>	Alaska
<i>F. calcarata</i>	East Africa
<i>F. carpatica</i>	Mountains of Hungary, Romania, etc.
<i>F. confertula</i>	Madeira Islands
<i>F. consanguinea</i>	East Africa
<i>F. diminuta</i>	Canary Islands
<i>F. fimbriata</i>	East Africa
<i>F. fissa</i>	King Island, Australia
<i>F. geniculata auct.</i>	Pacific Coast and northern Rocky Mountains in North America
<i>F. inflata sens. str.</i>	Auckland Islands
<i>F. inflata auct.</i>	Pacific Coast and northern Rocky Mountains in North America
<i>F. intricata</i>	China
<i>F. javanica</i>	Java
<i>F. minuscula auct.</i>	Boreal North America
<i>F. panizzei</i>	Mediterranean Old World
<i>F. parva</i>	Canary Islands

Species	Distribution
<i>F. pitardii</i>	Canary Islands
<i>F. pocsii</i>	East Africa
<i>F. portuensis</i>	Canary Islands, Atlantic-Lusitanian
<i>F. pumila</i>	Canton, China
<i>F. pusilla</i>	Canary Islands, widespread in Mediterranean Old World
<i>F. pusiola</i>	East Africa
<i>F. roesleri</i>	Boreal and Pacific Coast in N. America; circumboreal; northeastern in northern Europe; Asia
<i>F. scoparia</i>	Maritime Alaska
<i>F. subgeniculata</i>	Madeira Islands
<i>F. subpusilla</i>	East Africa
<i>F. tapperi</i>	East Africa
<i>F. tasmanica</i>	Tasmania
<i>F. translucida</i>	East Africa
<i>F. turgida</i>	Peru

NOTES ON HYPHOMYCETES. LIII.
MONOTRETOMYCES, A NEW DEMATIACEOUS,
CATENATE GENUS

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ABSTRACT

Monotretomyces uniseptatum Morgan-Jones, Sinclair and Eicker, a new genus and species, is described from a collection on decorticated wood in the Transvaal, South Africa.

INTRODUCTION

Extensive collecting of lignicolous, dematiaceous Hyphomycetes in the northeastern Transvaal, Republic of South Africa, has led to the discovery of many new and noteworthy taxa. In this paper, a new genus which forms tretoconidia in the manner of *Diplococcium* Grove and *Spadicoides* Hughes is described. It most closely resembles the former genus in that its conidia are catenate.

TAXONOMIC PART

Monotretomyces gen. nov.

Deuteromycotina, Hyphomycetes, Dematiaceae.

Etymology: Gr. *mono*, one; *tretos*, pierced/perforated; et *mykes*, fungus.

Coloniae effusae, densae, pilosae, atrae. Mycelium partim immersum, partim superficiale, ex hyphis pallide brunneis, laevis, ramosis, septatis compositum. Stromata plerumque superficialia, pallide brunnea vel brunnea, pseudoparenchymatica. Conidiophora ex stromatibus vel lateribusque hypharum oriunda, macronemata, mononemata, solitaria vel plerumque caespitosa, simplic-

ia, recta, septata, pallide brunnea vel brunnea, laevia, clavata. Cellae conidiogenae monotreticae, in conidiophoris incorporatae, terminales. Conidia acropleurogena, catenata, per poros ad apices conidiophori oriunda, oblonga, in extremis rotundata, laevia, sicca, brunnea, uniseptata.

Species typica: *Monotretomyces uniseptatum* Morgan-Jones, Sinclair et Eicker.

Colonies effuse, dense, hairy, black. Mycelium partly immersed, partly superficial, composed of pale brown, smooth, branched, septate hyphae. Stromata mostly superficial, pale brown to brown, prosenchymatous. Conidiophores arising from the stromata or laterally from hyphae, macronematous, mononematous, solitary or mostly caespitose, simple, straight, septate, pale brown to brown, smooth, clavate. Conidiogenous cells monotretic, integrated, terminal. Conidia acropleurogenous, catenate, arising through pores at the apices of the conidiophores, oblong with rounded ends, smooth, dry, brown, uniseptate.

Monotretomyces uniseptatum sp. nov. (Figure 1)

Coloniae extense effusae, densae, pilosae, atrae. Mycelium partim immersum, partim superficiale, ex hyphis pallide brunneis, laevis, ramosis, septatis, 2-3 μ m crassis compositum. Stromata plerumque superficiale, pallide brunnea, effusa vel pulvinata, interdum rudimentale, pseudoparenchymatica, ex cellulis brunneis, isodiametricis, compactis composita. Conidiophora ex cellulis superis stromatum vel hyphis superficialibus repentibus lateraliter oriunda, macronemata, mononemata, solitaria vel plerumque caespitosa, simplicia, recta, erecta, septata, pallide brunnea vel brunnea, laevia, clavata, 25-45 μ m longa, 2-2.5 μ m crassa ad basim, apicem versus 4-5 μ m crassa, usque ad 3 septata. Cellae conidiogenae monotreticae, in conidiophoris incorporatae, terminales, determinatae. Conidia acropleurogena, catenata, per poros ad apices conidiophori oriunda, oblonga, ad apicem et basem obtusa, laevia, sicca, brunnea, uniseptata, cum septum eccentricum, parietibus crassis, cellula apicalis longiora, pallide vel medio brunnea, 9-12 μ m longa et cellula basalis brevior, atro brunnea, 7-10 μ m longa, saepe guttulate, 16-22 X 5-7 μ m.

In ligno emortuis, Debengeni Waterfall, N.E. Transvaal, South Africa, August 17, 1979, R.C. Sinclair, AUA, holotypus.

Colonies spreading, sometimes extensively, usually dense, hairy, black. Mycelium partly immersed, partly superficial, composed of pale brown, smooth, branched, septate, 2-3 μ m wide hyphae. Stromata mostly superficial, pale brown, effuse to pulvinate, sometimes rudimentary, pseudoparenchymatous, composed of brown, isodiametric, mostly compact cells but frequently, at least in part, rather loosely organized with the cells appearing rounded rather than angular, at the margin almost prosenchymatous with swollen hyphal elements apparent. Conidiophores borne on the stromata or laterally from repent, thick-walled hyphae, macronematous, mononematous, solitary or, more often, when borne from superficial stromatic cells, caespitose, simple, straight, erect, septate, pale brown to brown, smooth, distinctly clavate, 25-45 μ m long, 2-2.5 μ m wide at the base, becoming 4-5 μ m wide at the apex when mature, with up to three septa. Conidiogenous cells monotretic, integrated, terminal, determinate, appreciably paler than the subtending, sterile conidiophore cells. Conidia acrogenous, catenate, arising through a single pore at the extreme apex of each

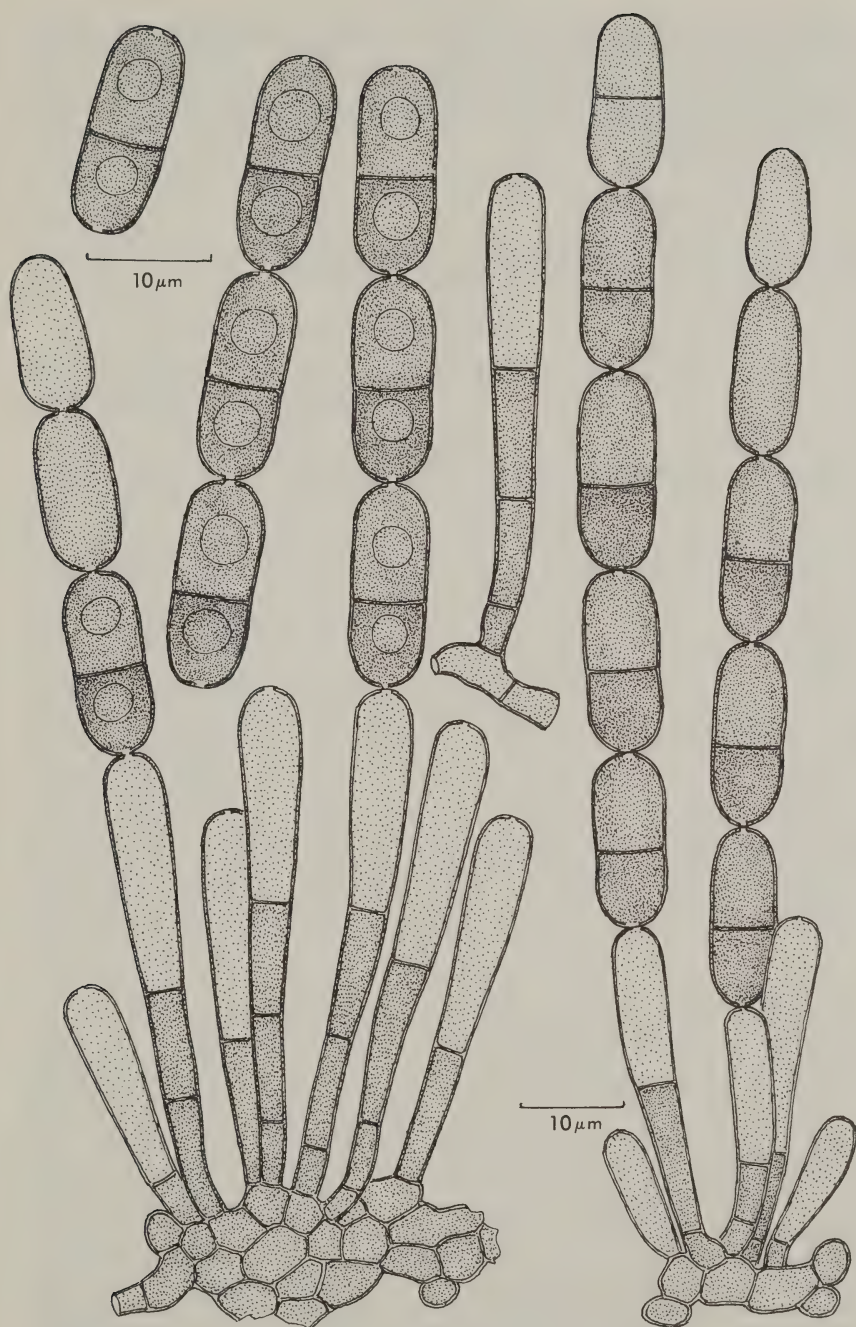


FIGURE 1. *Monotretomyces uniseptatum*; conidiophores and conidia.

conidiophore and of successive conidia, up to nine in unbranched chains, oblong, obtuse at each end, smooth, dry, brown, thick-walled, with a single, slightly eccentric septum, situated 1 to 2 μm nearer the base than the apex, separating a longer, pale to mid brown apical cell from a shorter, darker basal cell, usually with a single large guttule in each cell, 16-22 X 5-7 μm ; apical cell 9-12 μm long, basal cell 7-10 μm long.

On dead wood; South Africa.

Collection examined: Debengeni Waterfall, N.E. Transvaal, South Africa, August 17, 1979, R.C. Sinclair, AUA, holotype.

DISCUSSION

The generic relationships of *Monotretomyces*, as alluded to in the introduction, would seem to be with tretic genera having macronematous, thick-walled conidiophores, and integrated conidiogenous cells, such as *Diplococcium* and *Spadicoides*. Although species of *Spadicoides* generally have unbranched conidiophores (Ellis, 1971, 1976; Wang 1976; Wang and Sutton, 1982; Holubová-Jechová, 1982), the main distinction between it and *Diplococcium* lies in the fact that it bears solitary conidia (Sinclair *et al.*, 1985). The separation of the two genera on the presence or absence of conidial chains was questioned by Wang and Sutton (1982), who considered conidiophore branching to be a more useful distinguishing criterion. These authors transferred *Diplococcium asperum* Pirozynski into *Spadicoides* because of absence of conidiophore branching, in spite of its having catenate conidia. Sinclair *et al.* (1985), however, subsequently reported a collection of this species from South Africa bearing abundantly branched conidiophores. Because of this, the recombination of *D. asperum* into *Spadicoides* was rejected. Added to this, Bhat (1985) named a species, *S. subramanianii* Bhat, having branched conidiophores but solitary conidia. It can be argued that conidial catenation, or lack thereof, is a more stable feature than conidiophore branching, but we recognize that this is by no means always the case. Sinclair *et al.* (1985), by attaching primary importance to catenation, transferred four species of *Spadicoides* which have catenate conidia, namely *S. catenulatum* Wang & Sutton, *S. constrictum* Wang & Sutton, *S. grovei* M.B. Ellis, and *S. stoveri* M.B. Ellis into *Diplococcium*. Bearing in mind that some species of *Spadicoides* have conidia that are morphologically closely akin to those of several taxa now placed in *Diplococcium*, for example, *S. obovata* (Cooke and Ellis) Hughes has very similar conidia to *D. grovei* (M.B. Ellis) Sinclair, Eicker, & Bhat, doubt remains concerning a satisfactory generic classification of these fungi. It should be noted that, although *Diplococcium atrum* is known under some circumstances to produce branched conidiophores, such entities are infrequent, an exception rather than the rule. Conidiophore branching in *Diplococcium spicatum* Grove, the type species of *Diplococcium*, is consistently elaborate as are its conidial chains. The latter in the species of *Spadicoides* transferred to *Diplococcium* by Sinclair *et al.* (1985), are very short, usually made up of only two or three units, and inconsistent in occurrence. Furthermore, *Diplococcium constrictum* does not form comparable acropetal chains, but rather secondary conidia are occasionally produced singly from the basal cell of the primary conidium. As more taxa in this complex are discovered and described, and more collections exhibiting morphological variation are made, the distinction between the two genera becomes increasingly blurred. A strong case could, in fact, be made for uniting them, in which case *Diplococcium* would have date priority. Further

consideration of this matter is beyond the scope of the present paper.

Monotretomyces differs from both *Diplococcium* and *Spadicoides* in several respects. The single, terminal, monotretic conidiogenous cell per conidiophore contrasts sharply with the multiple, polytretic, terminal and intercalary conidiogenous cells of the latter genera. The conidiogenous cell of *Monotretomyces* is generally longer, broader, and paler in color than the subtending sterile cells of the conidiophore. This is not the case in *Diplococcium* and *Spadicoides* where terminal and intercalary cells are generally concolorous (with an exception in *D. asperum* where the conidiophore is usually appreciably paler near the apex), and of more or less equal width. The presence of stromata in *Monotretomyces* is another distinguishing feature, as is the caespitose arrangement of the conidiophores. In general appearance the conidial chains resemble those of *D. spicatum*, the type species of *Diplococcium*, but the conidia are not constricted towards the septum to the same degree as they are in that fungus.

Several other species in separate genera, *Bispora betulina* (Corda) Hughes, *B. novae-zelandiae* Matsushima, and *Corynespora biseptata* M.B. Ellis, also bear some similarity to *Monotretomyces*. Although the conidiogenous cells of *Bispora* Corda, as typified by *B. antennata* (Pers.) Mason, are considered to be monoblastic (Hughes, 1953; Ellis, 1971), in *B. betulina* they resemble those of species of *Corynespora* Güssow [type species *C. cassicola* (Berk. & Curt.) Wei = *C. mazei* Güssow], which are usually described as being monotretic (for example by Ellis, 1971). When *B. betulina* is grown in pure culture on agar media, the acropetal chains of conidia produced are quite similar to those of *Monotretomyces*, both in ontogeny and morphology [Morgan-Jones and Sinclair, unpublished data; for illustration see Tubaki and Ito (1975)]. This is also true of *B. novae-zelandiae* [see Matsushima (1985)]. The distinction between *B. betulina* and *M. uniseptatum* lies mainly in the morphology of their conidiophores in nature and the presence of a dark band obscuring each conidial septum in the former species. Such bands link *B. betulina* to *B. antennata*, but they are, however, often absent when the former is grown *in vitro*. Both *B. antennata* and *B. betulina* have semimacronematous, inconspicuous conidiophores. *Corynespora biseptata* has acropetal chains of conidia produced in much the same manner as those of *Monotretomyces*, but it has the thick-walled macronematous conidiophores typical of *Corynespora*, which sometimes elongate by successive, percurrent, cylindrical proliferations.

The genus *Corynesporopsis* Kirk, established to accommodate *Corynespora quercicola* Borowska on account of its possession of catenate, cylindrical to ellipsoidal, euseptate conidia (Kirk, 1981), is another genus having some morphological resemblance to *Monotretomyces*. Its determinate, thick-walled, dark brown, monotretic conidiophores are, however, essentially identical to those of *Corynespora*. A second species of the genus, *Corynesporopsis indica* Kirk, has, interestingly, dark bands at the conidial septa (Kirk, 1983), giving its conidia the appearance of those of *Bispora*. In addition, the conidia of *C. indica* are narrowly truncate at each end when viewed from the side, resembling those of *B. antennata*, although in that species, the truncated portion is appreciably wider, giving detached conidia a barrel shape. Truncation, which can be sometimes be taken to be indicative of blastic rather than tretic conidiogenesis, appears to be a deceiving feature in *C. indica* since the base of a seceded conidium is convex (Kirk, 1981). A similar situation exists in *Podosporium rigidum* Schw., the type species of *Podosporium* Schw., where

conidia originate through narrow pores in the terminal conidiogenous cells but are distinctly truncate at the base following detachment. Whether or not a continuum exists, both in morphology and cell wall relationships during conidiogenesis among some of the fungi discussed above, must await transmission electron microscope studies. The application of the terms monoblastic and monotretic to members of this complex cannot always be made with confidence on the basis of studies with the light microscope. Given our present knowledge, the taxonomy of the group seems satisfactory although *Corynespora biseptata* may be a candidate for transfer into *Corynesporopsis*.

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NEW SPECIES AND NEW RECORDS OF XANTHOPARMELIA (LICHENIZED ASCOMYCOTINA) FROM AUSTRALIA

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ABSTRACT : The species *Xanthoparmelia ballingalliana* Elix & Johnston, *X. blackdownensis* Elix & Johnston, *X. calida* Elix & Johnston, *X. condensinensis* Elix & Johnston, *X. darlingensis* Elix & Johnston, *X. hybridiza* Elix & Johnston, *X. nonreagens* Elix & Johnston, *X. stuartensis* Elix & Johnston, *X. victoriana* Elix & Johnston, *X. wisangerensis* Elix & Johnston, *X. yowaensis* Elix & Johnston and *X. zonata* Elix & Johnston are described as new. The new combinations, *X. fumigata* (Kurok.) Elix & Johnston, *X. nana* (Kurok.) Elix & Johnston and *X. pantherina* (Kurok.) Elix & Johnston have been made. *X. subnigra* Hale is reported for the first time from Australia.

Introduction

The lichen genus *Xanthoparmelia* (Vain.) Hale is especially well represented in Australia, and in a recent monograph we recognised 117 species from the region (Elix, Johnston & Armstrong 1986). Over the past two years we have had the opportunity to examine many more specimens from inaccessible areas of the continent and now wish to describe a further twelve new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

***Xanthoparmelia ballingalliana* Elix & Johnston sp.nov.**

Fig.1

Species cum thallo ut in *Xanthoparmelia amplexula* sed ab hac specie acidum colensoicum continente differt.

Type. Australia. Queensland. On basalt rocks on great basalt wall, Red Falls, Lolworth Creek, 58 km west-north-west of Charters Towers, 330 m, 19°55'S, 145°44'E, J. A. Elix 20490 & H. Streimann, 21.vi.1986; CBG-holotype.

Thallus small foliose, saxicolous, adnate to tightly adnate, yellow-green in colour, 1-3 cm in diameter; *lobes* subirregular to sublinear-elongate, 0.5-1.0(-1.5) mm wide, irregularly branched, imbricate or not so. *Upper surface* shiny at least apically, emaculate, margins smooth, becoming tangentially or irregularly cracked, isidiate; *isidia* laminal in the thallus centre, simple, globose at first then cylindrical, simple or expanding laterally and becoming branched, short, coralloid; medulla white. *Lower surface* pale brown, apices darker, shining, moderately to sparsely rhizinate, rhizines short, simple, concolorous with the lower surface. *Apothecia* sessile, to 2 mm in diameter, disc dark brown, shiny, concave, margin thick, involute, amphithecium

smooth, sparingly isidiate, spores (8), 8-10 x 4.5-5.5 μ m.

Chemistry. Cortex K-, medulla K-, C-, KC-, P-; containing usnic acid, colensoic acid (major) and traces of scabrosin 4-acetate-4'-butyrate ($\pm$), scabrosin 4-acetate-4'-hexanoate ($\pm$), scabrosin 4,4'-dibutyrate ($\pm$), scabrosin 4,4'-diacetate ($\pm$), unknown fatty acids.

In appearance this new species closely resembles *Xanthoparmelia amplexula* (Stirt.) Elix & Johnston. However *X. ballingalliana* generally has more diminutive thalli (1-3 cm) that are more tightly adnate and the isidia are globose to short cylindrical. In *X. amplexula* the thalli are usually larger (5-10 cm), more loosely adnate and the isidia are elongated-cylindrical and often densely coralloid branched. Even so these taxa are most reliably differentiated by chemical means.

X. ballingalliana invariably contains colensoic acid (KC-) as the major medullary constituent while *X. amplexula* contains loxodin and norlobaridone (KC+ rose). Both species may contain accessory fatty acids and scabrosin derivatives. Colensoic acid is very rare in genus *Xanthoparmelia*, having been recognized as a major constituent in only three other taxa: *Xanthoparmelia lividica* Hale and *X. stenosporonica* Hale, subcrustose South African species with a black lower surface; and *Xanthoparmelia peruviansis* Hale, a terricolous species with terete lobes from South America.

The superficially similar taxa *X. amplexula* and *X. ballingalliana* exhibit distinctly different geographic distributions. Thus *X. ballingalliana* appears to be confined to inland areas of southern Queensland while *X. amplexula* is widely distributed throughout Australia and New Zealand and also occurs in South Africa. This new species is named in honour of M. E. (Betty) Ballingall, who first brought the odd south-east Queensland *Xanthoparmelia* flora to our attention.

Specimens Examined

QUEENSLAND. On rocks, Castles area, 14 km south of Yowa Opal Field, west of Cunnamulla, M. E. Ballingall 1665 pr.p., 25.ix.1984 (ANUC); on sandstone rocks in *Eucalyptus-Xanthorrhoea* dominated woodland, Mt. Bohle, 34 km south-west of Charters Towers, 20°17'S, 146°01'E, 400 m, J. A. Elix 20619, 20637 & H. Streimann, 22.vi.1986 (ANUC); in sheltered rock crevices in *Eucalyptus* woodland with *Triodia*, 36 km east of Mt. Isa, 20°43'S, 139°51'E, 430 m, J. A. Elix 20656, 20659, 20667, 20672, 20673 & H. Streimann, 24.vi.1986 (ANUC); on weathered rocks in *Eucalyptus* dominated woodland, Whitecliff Gorge Creek, Hann (The Lynd) Highway, 56 km NNE of Hughenden, 20°20'S, 144°24'E, 550 m, J. A. Elix 20744 & H. Streimann, 26.vi.1986 (ANUC).

Xanthoparmelia blackdownensis Elix & Johnston sp.nov.

Fig.2

Species cum thallo ut in *Xanthoparmelia ajoensis* sed ab hac specie thallo minore et lobis angustioribus differt.

Type. Australia. On sandstone rocks in low *Eucalyptus* woodland-heathland with *Banksia oblongifolia* and *Leptospermum* spp., Leichhardt district, Blackdown Tablelands, ca. 1 km north of Horseshoe Lookout, 23°46'S, 149°12'E, 600 m, D. Verdon 5243, 27.i.1983 (CBG 8301152-holotype).

Thallus small foliose, saxicolous, adnate to tightly adnate, yellow-green, 1-2 cm in diameter; lobes subirregular to sublinear-elongate, stellate, 0.5-1.0 mm wide, irregularly branched, barely imbricate or not so. **Upper surface** shiny at least near the apices, emaculate, margins smooth, becoming tangentially or irregularly cracked, isidiate, **isidia** laminal in the thallus centre, cylindrical, simple; medulla white. **Lower surface** pale to light brown, apices darker, shining, moderately to sparsely rhizinate, rhizines short, simple, concolorous with the lower surface. Apothecia not seen.

Chemistry. Cortex K-, medulla K-, C-, KC-, P-; containing usnic acid, diffractaic acid (major), 4-O-demethylbarbatic acid (minor), 3- α -hydroxybarbatic acid (trace).

The presence of cylindrical isidia, a pale lower surface and the production of diffractaic acid in the medulla immediately bring the North American *Xanthoparmelia ajoensis* (Nash) Hale to mind. However the latter has much larger thalli (5-8 cm) with broader (1.0-3.0 mm), thicker, coriaceous lobes in comparison to *X. blackdownensis* with diminutive thalli (1-2 cm) with narrower (0.5-1.0 mm), thin, relatively fragile lobes. Furthermore these two species differ in the satellite compounds which accompany the predominant diffractaic acid: *X. blackdownensis* contains 4-O-demethylbarbatic acid (minor), 3- α -hydroxybarbatic acid (trace) while *X. ajoensis* has barbatic acid, constipatic acid ($\pm$), protoconstipatic acid ($\pm$), baeomycesic acid ($\pm$), squamatic acid ($\pm$), 4-O-demethylbarbatic acid ($\pm$), 2-O-methylobtusic acid ($\pm$ trace) and 3- α -hydroxybarbatic acid ($\pm$ trace). *Xanthoparmelia nashii* Elix & Johnston, an Australian species with similar chemistry to *X. blackdownensis*, differs in having broader lobes with a black lower surface.

The only Australian species which might be confused with *X. blackdownensis* is *X. centralis* as these two species are also closely related chemically and exhibit chemosyndromic variation - barbatic acid predominates in *X. centralis* and diffractaic acid in *X. blackdownensis*. However these two species differ in degree of adnation, the lobe width and the form of the isidia. The lobes of *X. centralis* are broader (0.5-1.5 mm) and tightly adnate while those of *X. blackdownensis* are narrow (0.3-0.6 mm) and moderately adnate. Also the isidia are cylindrical in *X. blackdownensis* but globose and erumpent in *X. centralis*.

Xanthoparmelia calida Elix & Johnston sp.nov.

Fig.3

Species cum thallo ut in *Xanthoparmelia exillima* sed ab hac specie colore subtus nigro differt.

Type. Australia. Queensland. On volcanic rocks in *Eucalyptus* - *Planchonia* dominated grassland, Andromache River, 25 km south-west of Proserpine, 80 m, 20°35'S, 148°26'E, J.A. Elix 21180 & H. Streimann, 2.vii.1986; CBG-holotype.

Thallus small foliose to subcrustose, saxicolous, very tightly adnate, yellow-green but darkening to deep olive-brown or blackish in older lobes, 2-4 cm in diameter; lobes subirregular to linear-elongate, contiguous, 0.2-0.8 mm wide, irregularly branched, not at all imbricate, becoming cracked and often forming areolae 0.2-0.5 mm in diameter in the thallus centre, simply appearing as fragmentary lobules in depauperate specimens. *Upper surface* opaque, emaculate, isidiate; *isidia* sparse, fragile, small (0.1-0.2 mm), globose at first then cylindrical, simple or expanding laterally and becoming branched, coralloid; medulla white. *Lower surface* black, sparsely rhizinate, rhizines black, simple, robust. *Apothecia* not seen.

Chemistry. Cortex K-, medulla K-, C-, KC+ rose, P-; containing usnic acid norlobaridone (major), scabrosin 4-acetate-4'-butyrate, scabrosin 4-acetate-4'-hexanoate, scabrosin 4,4'-dibutyrate, unknown scabrosin (trace).

This new species is characterised by the tightly adnate, subcrustose thallus, the narrow, linear-elongate lobes, the black lower surface and the production of cylindrical isidia and medullary norlobaridone. This species is closely related to the more common *X. exillima* (Elix) Elix & Johnston. These two species differ only in the colour of the lower surface - this being black to black-brown in *X. calida* but pale tan to brown in *X. exillima*. *X. thamnoides* (Kurok.) Hale has a similar chemistry and a black lower surface, but this species has adnate, foliose thalli with much broader lobes (2-4 mm) while *X. calida* is subcrustose in part with very narrow (0.2-0.5 mm), tightly adnate lobes.

Specimens Examined

QUEENSLAND. On basalt rocks in poor, scrubby forest, Charleys Creek, 18 km NNE



Figures 1-4. New species of *Xanthoparmelia*. 1 *X. ballingalliana* (holotype in CBG); 2 *X. blackdownensis* Elix & Johnston (holotype in CBG); 3 *X. calida* (holotype in CBG); 4 *X. condaminensis* (holotype in CBG). Scale in mm.

of Proserpine, 19°15'S, 148°39'E, 50 m, *J.A. Elix 21005 & H. Streimann*, 30.vi.1986 (ANUC); Type locality, *J.A. Elix 21178 & H. Streimann*, 2.vii.1986 (ANUC); on granite rocks in *Eucalyptus - Planchonia* dominated woodland, The Maiden Mountain, 40 km WNW of Bowen, 19°56'S, 147°52'E, 120 m, *J.A. Elix 21187, 21196 & H. Streimann*, 3.vii.1986 (ANUC).

***Xanthoparmelia condaminensis* Elix & Johnston sp.nov.**

Fig.4

Species cum thallo ut in *Xanthoparmelia terrestris* sed ab hac specie acidum constipaticum et acidum protoconstipaticum continente differt.

Type. Australia. Queensland. On soil in heath area, east of Condamine, Condamine Highway, *M. E. Ballingall & G. R. Scott*, 18.viii.1984; CBG-holotype.

Thallus foliose, loosely attached to soil or debris, pale yellow-green, forming irregular patches or rosettes to 10 cm in diameter; *lobes* elongate, subdichotomously divided, revolute to weakly convolute, 1.0-3.0 mm wide, often entangled, imbricate. *Upper surface* dull, smooth to slightly rugulose, emaculate, convex, lacking soredia and isidia; medulla white. *Lower surface* pale tan to light brown, apices darker, very sparsely rhizinate, rhizines concolorous with the lower surface, simple or tufted, robust. *Apothecia* rare, subpedicellate, 1.0-3.0 mm in diameter, disc weakly concave, dark brown, smooth; margin thick, entire, amphithecium smooth; spores (8), ellipsoid, 7-9 x 4-5µm.

Chemistry. Cortex K-, medulla K-, C-, KC-, P-; containing usnic acid, constipatic acid, protoconstipatic acid, and traces of scabrosin 4-acetate-4'-butyrate (±), scabrosin 4-acetate-4'-hexanoate (±) and scabrosin 4,4'-dibutyrate (±).

This species is characterised by the terricolous substrate, the elongated revolute lobes and the production of constipatic acid, protoconstipatic acid and the scabrosin derivatives in the medulla. Morphologically this species closely resembles *X. terrestris* (Kurok. & Filson) Elix & Johnston as both species form subpulvinate clumps on soil, often produce terete to subterete lobulae and have a pale brown lower surface. However *X. terrestris* is readily distinguished chemically since the medulla reacts K+ yellow becoming red and P+ yellow-orange due to the presence of norstictic and salazinic acids, while *X. condaminensis* gives no colour reactions. These two taxa could be considered chemical races. As they have very distinctive distributions and the medullary constituents are biosynthetically remote we prefer to consider them as distinct species (Elix 1982). *X. condaminensis* is confined to inland areas of southern Queensland whereas *X. terrestris* is found in inland areas of southern Western Australia, South Australia and western Victoria.

X. condaminensis could be considered to be related to *X. craveni* Elix & Johnston as these two species have identical chemistry and a pale brown lower surface. However the lobes of *X. condaminensis* are usually convex on the upper surface and more or less canaliculate below, whereas those of *X. craveni* are flat and never canaliculate. Furthermore *X. craveni* is tightly adnate on rocks while *X. condaminensis* is loosely adnate on soil. *X. nebulosa* (Kurok. & Filson) Elix & Johnston, a saxicolous species containing aliphatic acids, is distinguished by having more adnate, plane lobes and in medullary chemistry (*X. nebulosa* lacks the scabrosin derivatives and contains an unknown aliphatic acid as the major constituent). This new species is known only from the type locality.

***Xanthoparmelia darlingensis* Elix & Johnston sp.nov.**

Fig.5

Species cum thallo ut in *Xanthoparmelia louisii* sed ab hac specie lobis latioribus et acidum sticticum, acidum norsticticum, acidum consticticum et acidum cryptosticticum continente differt.

Type. Australia. Western Australia. On granite rocks in *Eucalyptus* forest, Serpentine Dam, Darling Ranges, *J. A. Elix 10796 & L. H. Elix*, 28.x.1982; CBG-holotype.

Thallus small foliose to subcrustose, saxicolous, very tightly adnate, yellow-green but darkening to deep olive-brown or blackish in older lobes, 2-3 cm in diameter; *lobes* stellate, linear-elongate, 0.2-0.8(-1.0) mm wide, dichotomously but sparingly branched, not at all imbricate, becoming cracked. *Upper surface* opaque, emaculate, often developing tangential cracks in the older lobes, lacking soredia and isidia; medulla white. *Lower surface* black, densely rhizinate, rhizines black, simple, robust. Apothecia not seen.

Chemistry. Cortex K-, medulla K+ yellow, C-, P+ orange; containing usnic acid, stictic acid (major), constictic acid (minor), norstictic acid (minor) and cryptostictic acid (trace), barbatic acid (major), 4-O-demethylbarbatic acid (minor).

This new species is characterised by the tightly adnate, subcrustose thallus; the linear-elongate, stellate, dichotomously divided lobes, the black lower surface and by the production of both barbatic acid and stictic acid (and their satellite compounds) in the medulla. This chemical combination is unique amongst the *Xanthoparmeliae* and this species could be envisaged as being derived by hybridization of two morphologically closely allied species, namely *X. adhaerens* (Nyl.) Hale [which contains the stictic acid complex] and *X. louisii* Elix & Johnston [which contains barbatic acid and 4-O-demethylbarbatic acid]. This new species is known only from the type collection.

Xanthoparmelia hybridiza Elix & Johnston sp.nov.

Fig.6

Species cum thallo ut in *Xanthoparmelia lineola* sed ab hac specie acidum barbaticum et acidum 4-O-demethylbarbaticum continente differt.

Type. Australia. South Australia. On beach pebbles along the foreshore, King George Beach, Kangaroo Island, 35°40'S, 137°04'E, 2 m, *J. A. Elix 19748 & L. H. Elix*, 30.x.1985; CBG-holotype.

Thallus foliose, saxicolous, adnate to tightly adnate, yellow-green, darkening with age, 5-8 cm in diameter; *lobes* sublinear-elongate, 1.0-2.0 mm wide, irregularly branched, barely imbricate, apices ± rotund, older lobes sometimes becoming irregularly cracked and areolate, areolae 1.0-2.5 mm wide. *Upper surface* opaque, emaculate, often tangentially or irregularly cracked, older lobes becoming rugulose and eventually areolate, apices often black marginate, lacking soredia and isidia; medulla white. *Lower surface* pale tan to brown, often darkening to grey-black at the lobe apices, moderately to densely rhizinate, rhizines brown, simple, slender. *Apothecia* adnate, 1.0-4.0 mm in diameter, disc concave then undulate, dark brown, margin thick, involute at first then becoming thinner and crenate, amphithecium smooth; spores (8), ellipsoid, 7-9 x 4-5 µm.

Chemistry. Cortex K-, medulla K+ yellow-red, C-, P+ yellow-orange; containing usnic acid, barbatic acid (major), salazinic acid (major), 4-O-demethylbarbatic acid (trace), norstictic acid (± trace) and consalazinic acid (minor).

This species is characterised by the tightly adnate thallus; the broad lobes which are rotund at the apices, the pale lower surface and the development of tangential cracks in the upper surface of older lobes. This combination of characters is typical of the so-called *X. lineola* group (Elix, Johnston & Armstrong 1986) and in particular of *X. lineola* (Berry) Hale itself. This new species can be distinguished from *X. lineola* only by chemical means and could be considered a chemical combinant (Elix 1982) or hybrid of *X. lineola* and *X. barbatica* (Elix) Egan, another member of this complex. However *X. hybridiza* does not develop loosely adnate secondary lobes like *X. barbatica*. Furthermore *X. hybridiza* has a more southerly distribution in Australia than the other two species, although the ranges do overlap to a minor extent. Thus *X. hybridiza* is

most common in the cooler, wetter areas of southern Australia, while *X. barbatica* is found throughout eastern Australia (Queensland to Victoria), and *X. lineola* is most common in the arid and subarid areas of inland Australia (Western Australia, Northern Territory, South Australia and New South Wales). Hence we prefer to give this taxon species status (Elix 1982; Elix, Johnston & Armstrong 1986). Another related species, *X. ferruma* Elix & Johnston lacks the linear-elongate marginal lobes and contains medullary skyrin as well as salazinic acid and consalazinic acid. *X. ferruma* occurs in the relative dry areas of central South Australia.

Specimens Examined

NEW SOUTH WALES. On rocks in black *Acacia* scrub, Byadbo Range, 50 km west of Bombala, Kosciuszko National Park, 1100 m, *J. A. Elix 10874* & *M. F. Day*, *J. A. Elix 10880* & *M. F. Day* 16.ii.1983 (ANUC).

VICTORIA. On roadside granite outcrops in disturbed *Eucalyptus* woodland, Wangaratta district, Tarrowingee-Beechworth road, 9 km WSW of Beechworth, 36°24'S, 146°35'E, 280 m, *J. Johnston 1646*, *J. Johnston 1649*, *J. Johnston 1653*, 12.xii.1984 (ANUC).

TASMANIA. On small boulders along the beach, Great Oyster Bay Coastal Reserve, near Mayfield on Highway 43, sea level, *M. E. Hale 68584*, 30.i.1985 (US).

SOUTH AUSTRALIA. On exposed schist rocks in cliff-top heath, Scotts Cove Lookout, 3 km east of Cape Borda, Kangaroo Island, 35°46'S, 136°37'E, 120 m, *J. A. Elix 19714*, *19716* & *L. H. Elix*, 29.x.1985 (ANUC); Type locality, *J. A. Elix 19750* & *L. H. Elix*, 30.x.1985 (ANUC).

WESTERN AUSTRALIA. On exposed granite rocks, Boulder Rock Forest Reserve, 35 km south-east of Perth, Darling Ranges, *J. A. Elix 10533* & *L. H. Elix*, 21.x.1982 (ANUC).

Xanthoparmelia nonreagens Elix & Johnston sp.nov.

Fig.7

Species cum thallo ut in *Xanthoparmelia immutata* sed ab hac specie isidiis cylindricis, coralloideis et acidum constipaticum et acidum protoconstipaticum deficiente differt.

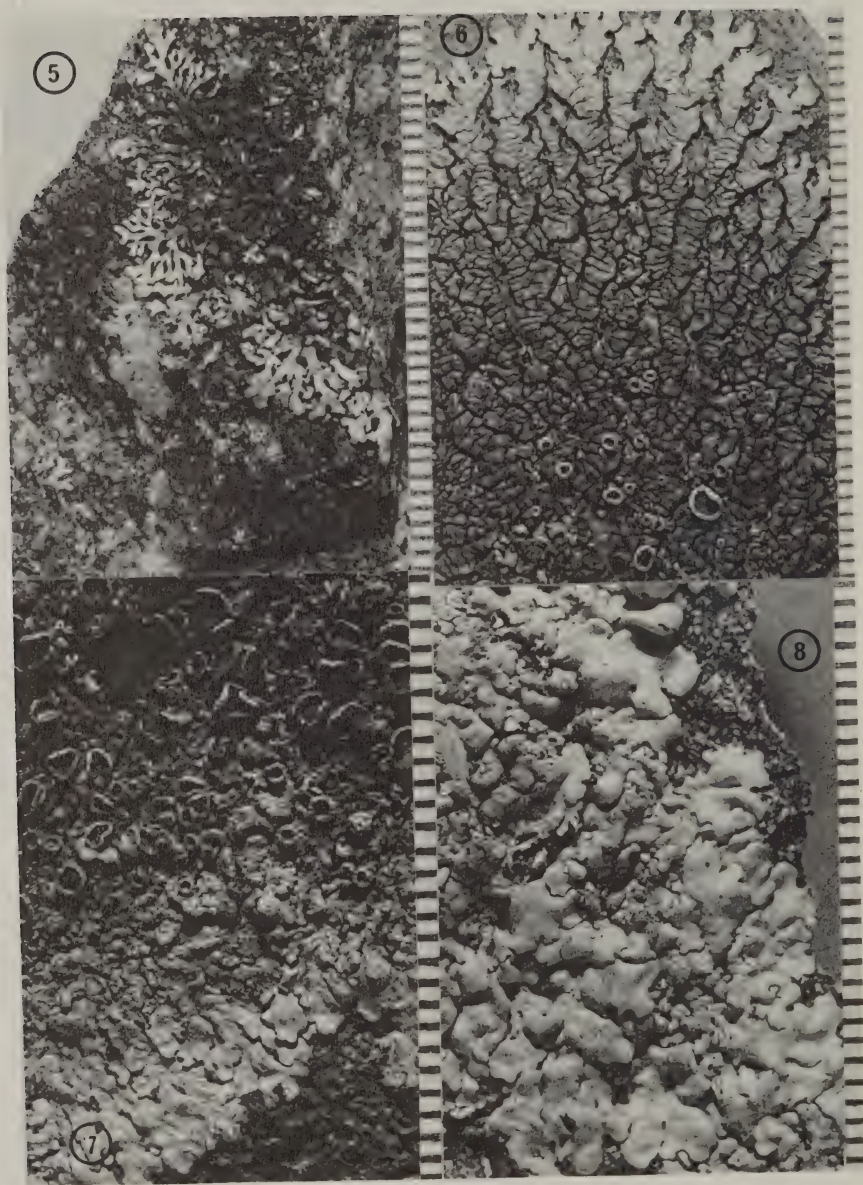
Type. Australia. Queensland. On sandstone rocks in dry sclerophyll forest on rocky slope, Mt. Farrenden, 26 km SSW of Charters Towers, 20°19'S, 146°13'E, 450 m, *J. A. Elix 20562* & *H. Streimann*, 22.vi.1986; CBG-holotype.

Thallus small foliose to subcrustose, saxicolous, very tightly adnate, yellow-green but darkening to deep olive-brown or blackish in older lobes, 2-4 cm in diameter; lobes subirregular to linear-elongate, contiguous, (0.2)0.5-1.0 mm wide, irregularly branched, not at all imbricate, becoming cracked and often forming areolae 0.2-0.5 mm in diameter in the thallus centre; simply appearing as fragmentary lobules in depauperate specimens.

Upper surface opaque, emaculate, older lobes often developing tangential cracks, isidiate; *isidia* small (0.1-0.2 mm), dense, cylindrical, simple or sparingly branched, brown-tipped, fragile; medulla white. *Lower surface* pale tan, sparsely rhizinate, rhizines concolorous, simple, robust. *Apothecia* rare, to 4 mm in diameter, disc weakly concave at first, then plane or ± undulate, brown to dark brown; margin thin, entire, persistent, densely isidiate, amphithecium densely isidiate, spores (8), ellipsoid, 7-9 x 4-5 µm.

Chemistry. Cortex K-, medulla K-, C-, KC-, P-; containing usnic acid, scabrosin 4,4'-dibutyrate, scabrosin 4-acetate, 4'-butyrate, scabrosin 4-acetate, 4'-hexanoate, scabrosin 4,4'-diacetate (±).

This species is characterised by the tightly adnate, small foliose to subcrustose thallus, the narrow, linear-elongate lobes, the pale lower surface and by the production of cylindrical isidia and medullary scabrosins. This species would appear to be closely related to *X. immutata* Elix & Johnston. These two species differ in medullary chemistry and the nature of the isidia, which are cylindrical and ± coralloid in *X.*



Figures 5-8. New species of *Xanthoparmelia*. 5 *X. darlingensis* (holotype in CBG); 6 *X. hybridiza* (holotype in CBG); 7 *X. nonreagens* (holotype in CBG); 8 *X. stuartensis* (holotype in CBG). Scale in mm.

nonreagens but globose-inflated in *X. immutata*. Both species contain medullary scabrosin derivatives, but *X. immutata* also contains the fatty acids, constipatic acid and protoconstipatic acid. *X. nonreagens* is known from several localities in north-central Queensland while *X. immutata* is a rare central Australian species.

Specimens Examined

QUEENSLAND. Type locality, J.A. Elix 20550, 20569 & H. Streimann, 22.vi.1986 (ANUC,US); on weathered rocks in *Eucalyptus* dominated woodland, Whitecliff Gorge Creek, Hann (The Lynd) Highway, 56 km NNE of Hughenden, 20°20'S, 144°24'E, 550 m, J.A. Elix 20743 & H. Streimann, 25.vi.1986 (ANUC).

Xanthoparmelia stuartensis Elix & Johnston sp.nov.

Fig.8

Species cum thallo ut in *Xanthoparmelia mexicana* sed ab hac specie isidiis simplicibus, ecoralloideis et acidum protocetraricum continente differt.

Type. Australia. Queensland. On volcanic rocks in disturbed *Eucalyptus* woodland, Mount Stuart, 10 km SSW of Townsville, 19°21'S, 146°47'E, 570 m, J. A. Elix 21227 & H. Streimann, 3.vii.1986; CBG-holotype.

Thallus foliose, saxicolous, adnate, yellow-green, to 6 cm in diameter; *lobes* irregular, 1.0-3.0 mm wide, imbricate or not. *Upper surface* broadly undulating, shiny at the margins but appearing subgranulate in the centre, emaculate, often black-margined, developing numerous erumpent or wart-like isidia; *isidia* laminal, small (to 0.3 mm high) in the thallus centre, simple, globose or short-cylindrical, entire; medulla white. *Lower surface* brown to dark brown, apices black-brown, moderately to sparsely rhizinate, rhizines short, simple, concolorous. *Apothecia* rare, to 4 mm in diameter, disc convex, brown to pale brown; margin involute at first, entire, persistent, isidiate, amphithecium densely isidiate, spores (8), ellipsoid, 8-10 x 4-6 µm.

Chemistry. Cortex K-, medulla K-, C-, KC-, P+ yellow; containing usnic acid, protocetraric acid (major) and virensic acid (minor).

This new species resembles *Xanthoparmelia mexicana* (Gyelnik) Hale since both develop isidia on the upper surface, have similar thalli and a pale lower surface, but they differ in medullary chemistry and the nature of the isidia. Thus in *X. mexicana* the dense, cylindrical isidia become coralloid-branched while *X. stuartensis* has sparse to moderately dense, simple, globose isidia which rarely become elongated and cylindrical. This species also resembles the African species, *X. fucina* Knox, which is isidiate, has a pale lower surface and contains medullary protocetraric acid. However *X. fucina* also contains skyrin in the medulla (not known in *X. stuartensis*) and again differs in that the cylindrical isidia are dense and coralloid-branched.

Specimens Examined

QUEENSLAND. Type locality, J. A. Elix 21236 & H. Streimann, 3.vii.1986 (ANUC).

Xanthoparmelia victoriana Elix & Johnston sp.nov.

Fig.9

Species cum thallo ut in *Xanthoparmelia crateriformis* sed ab hac specie thallo subtus brunneo differt.

Type. Australia. Victoria. On rocks in cleared mallee with sparse herbs, paddock adjoining Whipstick, Millwood Road, ca. 11.5 km NNE of Huntly, Bendigo District, 36°34'S, 144°20'E, ca.160 m, J. Johnston 1592, 11.xii.1984; CBG-holotype, MEL-isotype.

Thallus small foliose to subcrustose, saxicolous, very tightly adnate, yellow-green but darkening to deep olive-brown or blackish in older lobes, 2-4 cm in diameter; *lobes* stellate to contiguous, linear-elongate, 0.2-0.8(-1.0) mm wide, dichotomously but

sparingly branched, not at all imbricate, becoming cracked and often forming areolae 0.2-0.5 mm in diameter in the thallus centre. *Upper surface* opaque, emaculate, older lobes often developing tangential cracks, isidiate; *isidia* small (0.1-0.2 mm), simple, globose then distorted cylindrical, inflated, eventually erumpent at the apices but barely sorediate, dense in thallus centre; medulla white. *Lower surface* pale brown to brown, sparsely rhizinate, rhizines brown, simple, robust. *Apothecia* rare, sessile, to 1 mm in diameter, disc concave to plane, dark brown; margins prominent, entire, smooth, without isidia; spores (8), 7-9 x 5-6 μ m.

Chemistry. Cortex K-, medulla K+ yellow, C-, P+ orange; containing usnic acid, stictic acid (major), constictic acid (minor), norstictic acid (minor) and cryptostictic acid (trace).

This species is characterised by the tightly adnate, subcrustose thallus; the linear-elongate, $\pm$ stellate, dichotomously divided lobes; the pale brown lower surface and by the production of simple isidia and medullary stictic acid (and its satellite compounds). This species appears to be closely related to *X. crateriformis* Elix & Johnston. These two species differ chiefly in the colour of the lower surface - this being black to black-brown in *X. crateriformis* and pale brown to mid-brown in *X. victoriana*. This new species is known only from the type locality.

Specimens Examined

VICTORIA. Type location, *J. Johnston 1580*, 11.xii.1984 (ANUC, ASU, BM, CHR, US).

Xanthoparmelia wisangerensis Elix & Johnston sp.nov.

Fig.10

Species cum thallo ut in *Xanthoparmelia incrustata* sed ab hac specie thallo ad ambitum elobulato et acidum norsticticum et acidum connorsticticum continente differt.

Type. Australia. South Australia. On sandstone rocks in pasture, just south of Wisanger Hills Homestead, 7 km WSW of Emu Bay, Kangaroo Island, 35°37'S, 137°27'E, 80 m, *J. A. Elix 19648* & *L. H. Elix*, 27.x.1985; CBG-holotype; MEL-isotype.

Thallus foliose, saxicolous, adnate, yellow to pale yellow-green, 3-6 cm in diameter; lobes irregular to sublinear-elongate, 1.0-2.0(-3.0) mm wide, irregularly branched, imbricate, developing narrower (0.2-0.5 mm wide), linear-elongate, subdichotomously divided, subterete, secondary lobes in the thallus centre, secondary lobes revolute, canaliculate below. *Upper surface* emaculate, shiny, black marginate near the apices, primary lobes flat but secondary lobes convex, lacking soredia and isidia; medulla white. *Lower surface* pale tan, lobe apices often darkening to dark grey, sparsely to moderately rhizinate, rhizines brown, simple, slender. *Apothecia* substipitate, 1.0-3.0 mm in diameter, disc deeply concave, dark brown; margin thick, entire, involute and becoming crenulate to dentate, amphithecium smooth; spores (8), ellipsoid, 7-10 x 5-6 μ m.

Chemistry. Cortex K-, medulla K+ yellow-red, C-, P+ yellow; containing usnic acid, norstictic acid (major), salazinic acid (major), connorstictic acid (minor) and consalazinic acid (minor).

In some respects this new species resembles *Xanthoparmelia incrustata* (Kurok. & Filson) Elix & Johnston and *X. examplaris* Elix & Johnston as all three are adnate to rocks, have a pale lower surface and produce revolute secondary lobes in the thallus centre. However the latter two species produce convex marginal lobes with a canaliculate lower surface which are loosely adnate whereas the marginal lobes of *X. wisangerensis* are flat and adnate.

These three species also are distinguished chemically since *X. incrustata* produces medullary loxodin and norlobaridone, *X. examplaris* salazinic acid and consalazinic acid while *X. wisangerensis* produces norstictic and connorstictic acids in addition to salazinic acid and consalazinic acid. The former two species are known from arid inland

areas of Western Australia and South Australia whereas this new species is known only from Kangaroo Island (coastal).

***Xanthoparmelia yowaensis* Elix & Johnston sp.nov.**

Fig.11

Species cum thallo ut in *Xanthoparmelia karoo* sed ab hac specie acidum fumarprotocetraricum continente differt.

Type. Australia. Queensland. On rocks, The Bluff, Yowa Opal Field, near Cunnamulla, in *M. E. Ballingall 1668B*, 2.ix.1984; CBG- holotype.

Thallus foliose, saxicolous, adnate to tightly adnate, yellow-green, 3-5 cm in diameter; *lobes* subirregular, 1.5-3.0(-4.0) mm wide, irregularly branched, imbricate, apices $\pm$ rotund. *Upper surface* opaque, with distinct effigurate maculae, older lobes becoming markedly rugulose and wrinkled, apices often black marginate, lacking soredia and isidia; medulla white. *Lower surface* jet black, moderately to sparsely rhizinate, rhizines black, simple, robust. *Apothecia* not seen.

Chemistry. Cortex K-, medulla K+ pale yellow-brown, C-, P+ orange-red ; containing usnic acid, fumarprotocetraric acid (major), succinprotocetraric acid, protocetraric acid (trace), lobaric acid ($\pm$).

This species is characterised by the adnate to tightly adnate thallus, the black lower surface, the effigurate maculae on the upper surface and the production of medullary fumarprotocetraric acid. This combination of morphological characters is typical of the *X. hypoleia* group (Elix, Johnston & Armstrong 1986) and in particular of the South African, *X. karoo* Knox & Brusse. These are the only two species of the group which have tightly adnate thalli (the others have loosely adnate thalli with imbricate lobes or a pulvinate growth form). Even so they are morphologically distinct since *X. yowaensis* has broader, irregular lobes and contains fumarprotocetraric acid while *X. karoo* has narrow (0.8-1.5mm) linear-elongate lobes and contains hypoprotocetraric acid. This new species is closely related to *X. pseudohypoleia* (Elix) Elix & Johnston since both possess effigurate maculae and have identical chemistry. However *X. pseudohypoleia* is readily distinguished by the loosely adnate thalli with linear-elongate lobes. This new species is known only from the type locality.

Specimen Examined

QUEENSLAND. Type locality, *M. E. Ballingall 1667B*, 27.ix.1984 (ANUC).

***Xanthoparmelia zonata* Elix & Johnston sp.nov.**

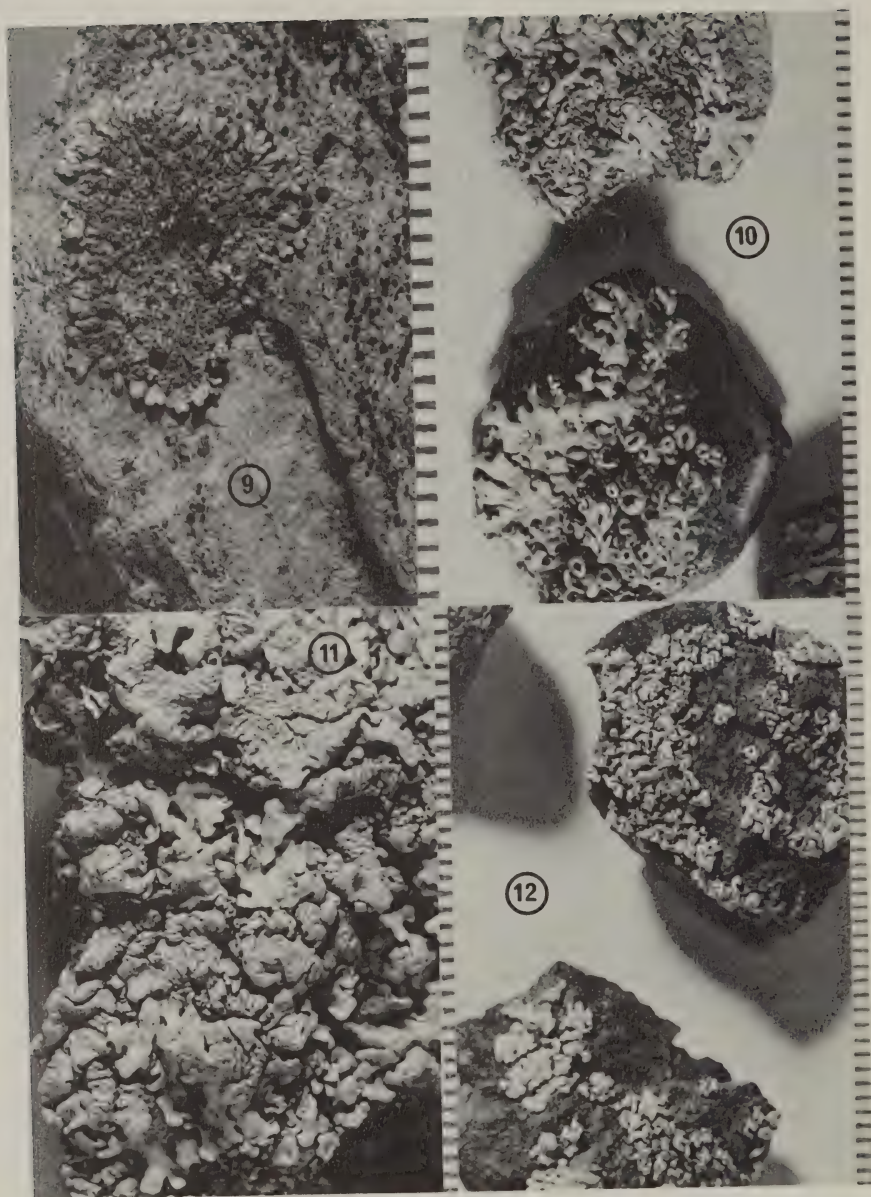
Fig.12

Species cum thallo ut in *Xanthoparmelia immutata* sed ab hac specie acidum lobaricum et skyrinum continente differt.

Type. Australia. Queensland. On rocks, Castles area, 14 km south of Yowa Opal Field, west of Cunnamulla, *M. E. Ballingall 1746A*, 25.ix.1984 ; CBG-holotype.

Thallus small foliose to subcrustose, saxicolous, tightly adnate, yellow-green but darkening with age, 1-3 cm in diameter; *lobes* irregular, 0.5-1.0 mm wide, barely imbricate or not so. *Upper surface* shiny at least near the apices, emaculate, margins smooth, becoming tangentially or irregularly cracked, older lobes becoming rugulose and areolate, isidiate; *isidia* laminal in the thallus centre, simple, globose, coarse, becoming short cylindrical, rarely branched but commonly inflated at the apices; *medulla* white for the most part, lower medulla intermittently pigmented yellow-orange. *Lower surface* pale to light brown, apices darker, shining, moderately to sparsely rhizinate, rhizines short, simple, concolorous with the lower surface. *Apothecia* not seen.

Chemistry. Cortex K-, medulla K-, C-, KC-, P- ; containing usnic acid, lobaric acid (major), constipatic acid (minor), protoconstipatic acid (minor), skyrin, scabrosin



Figures 9-12. New species of *Xanthoparmelia*. 9 *X. victoriana* (holotype in CBG); 10 *X. wisangerensis* (holotype in CBG); 11 *X. yowaensis* (holotype in CBG); 12 *X. zonata* (holotype in CBG). Scale in mm.

4-acetate-4'-butyrate, scabrosin 4-acetate-4'-hexanoate, scabrosin 4,4'-dibutyrate and traces of colensoic acid and scabrosin 4,4'-diacetate.

In overall appearance this new species closely resembles *Xanthoparmelia immutata* Elix & Johnston and *X. ballingalliana* (described above) and these taxa are most reliably differentiated chemically. All three species contain the aliphatic acids constipatic acid and protoconstipatic acid, and the three scabrosin derivatives but *X. zonata* also contains lobaric acid as the major medullary constituent plus skyrin in a zone adjacent to the lower cortex. Lobaric acid is rare in genus *Xanthoparmelia* having been recognized as a minor (accessory) constituent in several other taxa - e.g. *Xanthoparmelia protomatrae* (Gyelnik) Hale (Krog 1978). The major constituent of *X. ballingalliana* is colensoic acid while *X. immutata* contains no phenolic acids. This new species is known only from the type collection.

New Combinations

Xanthoparmelia fumigata (Kurok.) Elix & Johnston, comb. nov.

Basionym: *Parmelia fumigata* Kurok., *Bull. Natn. Sc. Mus., Tokyo*, ser. B, **11**, 81 (1985)

Xanthoparmelia nana (Kurok.) Elix & Johnston, comb. nov.

Basionym: *Parmelia nana* Kurok., *Bull. Natn. Sc. Mus., Tokyo*, ser. B, **11**, 86 (1985)

The affinities of this species were overlooked previously because of an incomplete chemical analysis of the type. TLC and HPLC examination of the type specimen have confirmed the presence of usnic acid, diffractaic acid (major), salazinic acid (minor) and traces of barbatic acid, consalazinic acid, 4-O-demethylbarbatic acid, norstictic acid, protocetraric acid, constipatic acid and protoconstipatic acid. The only other species with a similar combination of chemical and morphological characters is *X. lesotoensis* Hale from southern Africa (Hale 1986).

Xanthoparmelia pantherina (Kurok.) Elix & Johnston, comb. nov.

Basionym: *Parmelia pantherina* Kurok., *Bull. Natn. Sc. Mus., Tokyo*, ser. B, **11**, 88 (1985)

Previously known only from the type locality in southern Victoria, this species is reported now from South Australia.

Specimens Examined

SOUTH AUSTRALIA. On granite rocks in pasture, Borthwick Road, 6.5 km east of Tungkillo, Mt. Lofty Ranges, 470 m, *J. A. Elix* 9456, 9478 & *L. H. Elix*, 30.x.1981 (ANUC), *J. A. Elix* 10818, 10821 & *L. H. Elix*, 31.xii.1982 (ANUC).

New Record

Xanthoparmelia subnigra Hale

This species has previously been reported from South Africa (Hale 1986).

Specimens Examined

SOUTH AUSTRALIA. On sandstone rocks in open *Eucalyptus* woodland, lower slopes of Mt. Remarkable, Melrose, Flinders Ranges, 500 m, 32°50'S, 138°11'E, *J. A. Elix* 17748, 17758 & *L. H. Elix*, 26.x.1984 (ANUC); on quartzite rocks in pasture, just east of Wisanger Park Homestead, Kangaroo Island, 80 m, 35°37'S, 137°28'E, *J. A. Elix* 19628 & *L. H. Elix*, 27.x.1985 (ANUC).

ACKNOWLEDGEMENTS

We wish to thank Mr. I. A. Fox and the staff of the Science Photographic Unit, ANU, for preparing the photographs, Mr. D. Verdon for checking the Latin descriptions and Dr. G. A. Jenkins who determined the chemistry of many specimens. We thank Dr. S. Kurokawa (TNS) and Dr. M. E. Hale (US) for the loan of essential type material, M. E. Ballingall for critical collections and the Australian National University for financial assistance through the Faculties Research Fund and the Bureau of Flora and Fauna for financial support through the Australian Biological Resources Study Program.

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MYCOTAXON

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MORCHELLA VULGARIS PERS. EX FR. (MORCHELLACEAE) NOUVEAU POUR LE CHILI

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RÉSUMÉ.- Morchella vulgaris Pers. ex Fr., est collectionné pour la première fois au le Chili. D'autres espèces citée sont M.conica Pers. ex Fr. et M.conica var. angusticeps (Peck.) Speg.

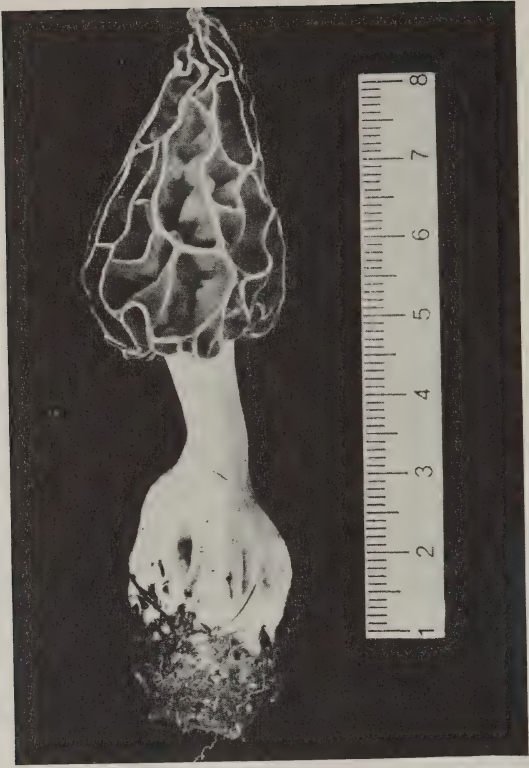
SUMMARY.- Morchella vulgaris Pers. ex Fr. is collected for the first time in Chile. Others species cited are M.conica Pers. ex Fr. and M.conica var. angusticeps (Peck.) Speg.

Parmi les espèces de Morchella citées pour le Chili on connaît M.conica, Spegazzini 1918, M.conica var. angusticeps Spegazzini 1912 et on a observé M.esculenta, Espinoza 1929 et Morchella sp., Gotschlich 1913.

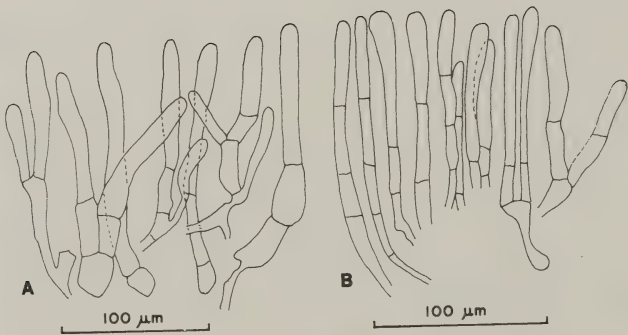
Exemplaires de Morchella il n'a pas dans l'herbier du Museo Nacional de Historia Natural de Santiago et les collections de Morchella dans le Chili sont rares. En considérant que les collections de Morchella ont été peu nombreux j'ai décidé écrire cette communication sur l'exemplaire que j'ai trouvé pendant le dernier Juillet dans la cote du Chili central. L'exemplaire je l'ai identifié comme Morchella vulgaris Pers. ex Fr., Fig.1.

DESCRIPTION.- Pied de 4 cm de haut, blanchâtre, glabre, subcylindrique et en part, un peu comprimée, épaissi à la base et avec quelques crevasses à niveau du sol.

Chapeau de 4,5 cm de haut et 2,8 cm de diamètre à la base, ovoïde, acute dans l'apice, alvéoles de bords sinueux tapis onduleux ou avec des crêtes, forme irrégulière et de 6 mm de profondeur dans la moitié inférieur et dans la part apical 2 mm, les formes des alvéoles et sa grandeur sont différents, son couleur ocre-jaune, quand sèche change à brunâtre, cretes pales, blanchâtre, avec longueur le plus grand en direction haut-bas.



1



2

Fig. 1. Morchella vulgaris Pers. ex Fr., spécimen 21870 (Herb. Mahuainum) règle en cm.

Fig. 2. Les deux clases de hyphas hymeniales (A,B) observée dans Morchella vulgaris Pers. ex Fr., spécimen 21870 (Herb. Mahuianum).

L'exemplaire n'a pas des spores, son hyménium est de 74 μ m haut. Dans l'hyménium on observe deux clases de hyphas, Fig.2: A, B. Quelques hyphas ont a l'extrême superieur una grande goutte de lipide et d'autres plusieurs et petites.

SPÉCIMEN ETUDIÉ ET HABITAT.- M.vulgaris Pers. ex Fr., Mahú 21870, fût colecté dans la Quebrada El Yugo, parmi les herbes au bord d'un maquis dense de Peumus boldus, Lithraea caustica et Trevoa trinervis a 60 msm et 33°20' S. 71°38' 30" W. en Algarrobo Norte, Prov. de San Antonio.

REMERCIEMENTS

Je remerci a Mlle. Marjatta Lassig, bibliothécaire du Département de Botanique de l'Université de Helsinki, pour m'envoyer part de la bibliographie citée, a M. les Prof. W. Lazo et L.Corcuera pour la lecture critique du manuscrit et a M. le Prof. Francisco Gouët par la révision du texte en francais.

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DACTYLARIA CONSTRICTA: DESCRIPTION OF TWO VARIETIES

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SUMMARY

The salient characteristics of two varieties of *Dactylaria constricta*, i.e., *D. constricta* var. *gallopava* and *D. constricta* var. *constricta*, are described.

INTRODUCTION

We have shown previously that *Dactylaria gallopava* (Cooke) Bhatt et Kendrick is morphologically indistinguishable from *Scolecobasidium constrictum* Abbott (Figs. 1-2) and proposed the new combination, *Dactylaria constricta* (Abbott) Dixon et Salkin (Dixon and Salkin, 1986). At that time, we noted in studies conducted with cultures derived from type specimens that the species could be separated into two groups on the basis of physiological criteria. We subsequently found that these two groups also differed in their virulence in experimentally infected mice (Fig. 3) (Dixon et al., 1987). We propose here varietal status for these two groups within *Dactylaria constricta*. The authors feel this change is necessary to reflect the close but distinct character of these two taxa.

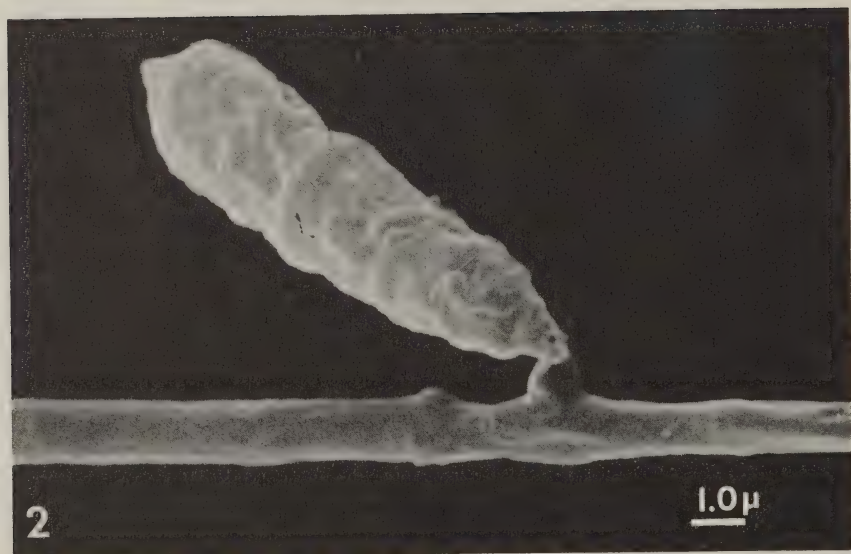
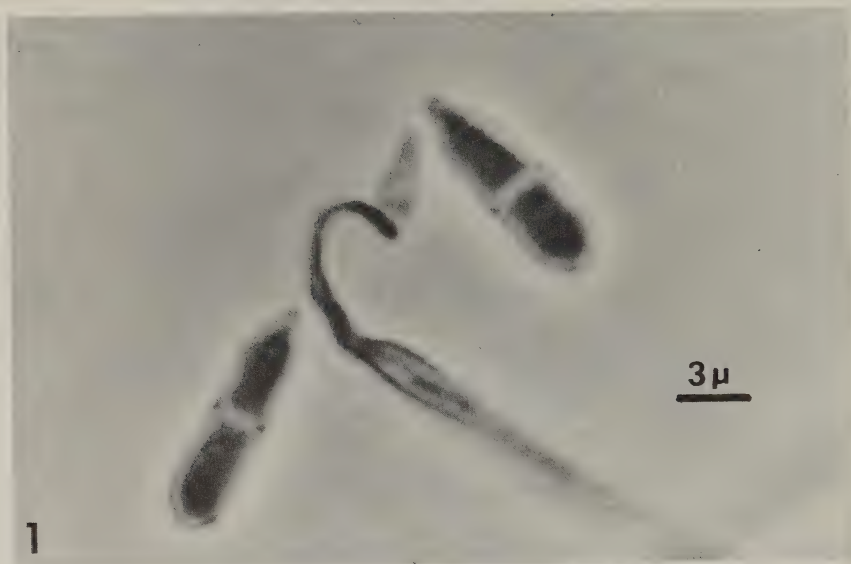


Fig. 1-2. Fig. 1. Elongate, 2-celled holoblastic conidia of **Dactylaria constricta** which have separated from conidiogenous cells by rhexolytic dehiscence. Fig. 2. Scanning electron micrograph of 2-celled **Dactylaria constricta** conidium.

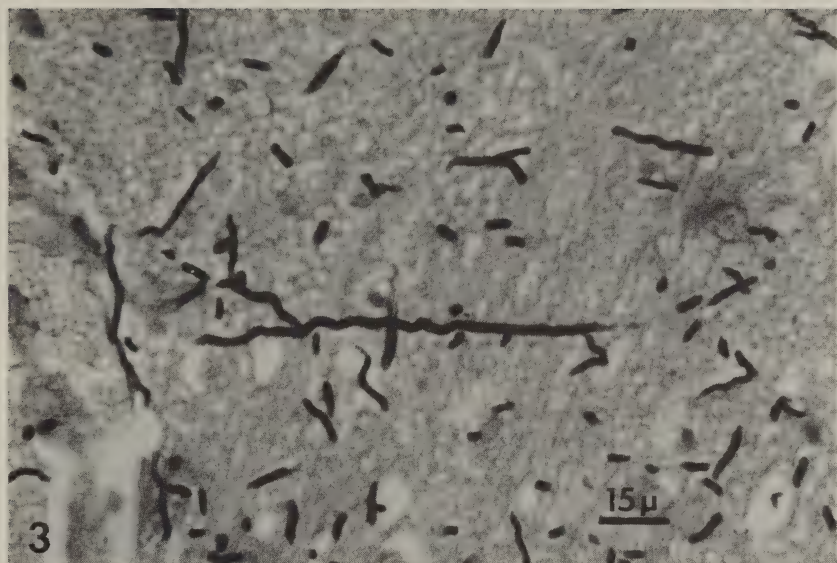


Fig. 3. Hyphal fragments, some with zig-zag appearance, invading mouse brain tissue 5-days after intravenous inoculation with 10^6 conidia of *Dactylaria constricta*.

TAXONOMY

Dactylaria constricta (Abbott) Dixon et Salkin var. *gallopava* (Cooke) Salkin et Dixon comb. nov.

Basionym: *Diplorhinostrichum gallopavum* Cook in Georg, Bierer and Cook, *Sabouraudia* 3:241, 1964.

Isolates give a delayed positive (>21 days) gelatin reaction, grow at 37 and 42°C, and do not grow on Mycosel agar (BBL, Cockeysville, MD) (Dixon and Salkin, 1986). Isolates are pathogenic in Swiss albino mice when conidia and mycelial fragments are inoculated intravenously. Isolates are highly virulent and neurotropic (Dixon et al., 1987).

Dactylaria constricta (Abbott) Dixon et Salkin var. *constricta*.

Basionym: *Scolecobasidium constrictum* Abbott, *Mycologia* 19:30, 1927.

Dried, permanently preserved neotype prepared from living culture DMD 410 (Dixon and Salkin, 1986) deposited as DMD 410 in the New York State Herbarium, Albany, New York.

Isolates grow on Mycosel agar and give a rapid, positive gelatin reaction (Dixon and Salkin, 1986). Isolates do not grow at 37°C and are not pathogenic in Swiss albino mice when tested through intravenous inoculation (Dixon et al., 1987).

DISCUSSION

Dactylaria constricta var. **gallopava** is a pathogen in birds and mammals (Georg, Bierer, and Cooke, 1964). While subcutaneous infections associated with this fungus have been reported in man, the central nervous system is the most severely involved site in experimentally infected mice (Dixon et al., 1987). The fungus is similar to **Xylohypha bantiana** and **Wangiella dermatitidis** in its involvement in central nervous system infections, as well as in its delayed positive gelatin reaction, growth at or above 40°C, and being a dematiaceous hyphomycete. The histopathology of the central nervous system infections in mice caused by these 3 fungi and **Fonsecaea pedrosoi** has recently been compared (Walsh et al., 1987).

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We thank Drs. F. A. Uecker of the U.S. Department of Agriculture, John H. Haines, N.Y. State Museum, Department of Education, and Donald Rogers, Professor Emeritus, Department of Botany, University of Illinois for their advice and critical review of the manuscript. We also thank Dr. W. Samsonoff of the Wadsworth Center for Laboratories and Research for the preparation of the scanning electron micrograph.

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CHAETOMIUM HISTOPLASMOIDES, A NEW SPECIES ISOLATED FROM CYSTS OF HETERODERA GLYCINES IN ILLINOIS

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During a three-year study on the mycota associated with cysts of *Heterodera glycines* Ichinohe we isolated a previously unknown species of *Chaetomium* with a *Histoplasma*-like anamorph. Herein we describe the fungus as a new species and compare it with the somewhat similar *C. piluliferum* Daniels.

The fungus was isolated from *H. glycines* cysts extracted from soybean field soil using a wet-seiving technique (Southey, 1970). Cysts were surface-sterilized 3 min in 0.5% NaOCl, rinsed in sterile water, and placed on water agar (Bacto-Agar, Difco, Detroit, MI). Subcultures were made from fungal mycelia growing from cysts. Cultures were maintained on Difco corn-meal agar (CMA) and subjected to fluorescent light (about 10 h daily) at 22-26 C.

Chaetomium histoplasmoides sp. nov., Figs. 1-15.

Coloniae in agar cum Zeae farina composito cultae die quinquedecima diametrum 4.4-6.7 cm attingentes; mycelio ex albido vinacente, denso. Perithecia fusco-brunnea, ovata, ostiolo obtuse rotundato, capillis tecto, peridio fusco-brunneo, e textura angulari vel epidermoidea composita, 128-224 X 96-200 μ m. Peritheccii capillae brunneae, septatae, ornamento cupulato vel globulari notatae, rectae vel conspiratae, 34-450 X 1.6-4.0 μ m. Asci clavati, tenuiter tunicati, octospori, deliquescentes, 27 X 10 μ m. Ascosporae brunneae, ellipsoides, levescontinuae, poro germinativo singillatim praeditae, 11.2-16 X 7.2-9.6 μ m. Anamorphosis Histoplasmati similis. Conidia rara vel abundantia, blastice producta, hyalina vel rufo-brunnea, globosa vel pyriformia, unicellularia, levigata vel distincte tuberculata, crasse tunicata, singula vel bina, sessilia vel in cellulis lateralibus conidiogenis gesta,

4-14 X 4-12 μm .

Fourteen-day-old colonies on CMA (Fig. 1) 4.4-6.7 cm diam, white to vinaceous, with dense aerial mycelium, uniformly woolly or concentrically zonate, with pale brown mycelial hairs present in some isolates; border even; reverse uncolored, occasionally with darkened center. **Anamorph Histoplasma-like. Conidia** (Figs. 2-7) sparse to abundant, formed blastically, hyaline to reddish-brown, vinaceous in mass, globose to pyriform, one-celled, smooth to distinctly tuberculate (tubercles hyaline, globose, collapsing, 1.6-8.8 X 1.6-8 μm), thick-walled, 4-14.4 X 4-12 μm ; single or in chains of two; sessile or on lateral, cylindrical to inflated conidiogenous cells up to 14.4 μm long, 4-7.2 μm wide. **Mycelial hairs** (Fig. 9) pale brown, cylindrical, tapering to bluntly rounded apices, septate, finely roughened, 16-630 X 2.4-4.8 μm ; repent in aerial mycelium or in clusters arising from hyphal knots resembling ascogonial coils (Fig. 8). **Perithecia** (Figs. 10-12) dark brown, ovate, with bluntly rounded ostiole, bordered by hyaline pseudoparenchymatous cells; covered with hairs; peridium dark brown, **textura angularis** to **textura epidermoidea** (Fig. 15); 128-224 X 96-200 μm . **Perithecial hairs** (Figs. 12, 13) brown, septate, with cupulate to globulate ornamentation (*fide* Hawksworth and Wells, 1973); terminal or lateral, straight to coiled; 34-450 X 1.6-4.0 μm . **Asci** clavate, thin-walled, 8-spored, deliquescent, with irregularly biseriate ascospores; 27 X 10 μm . **Ascospores** (Fig. 14) medium brown, ellipsoidal to narrowly ellipsoidal, smooth, one-celled with one apical germ pore, often collapsing to form longitudinal furrow (*fide* Ames, 1961); 11.2-16 X 7.2-9.6 μm .

Isolates examined: All isolated from cysts of *H. glycines* extracted from soil of soybean [*Glycine max* (L.) Merrill] field near Sydney, Champaign Co., Illinois. S-6-1-20, S-6-2-5, S-6-4-9, isolated 30.VIII.1984; S-7-5-5, isolated 20.IX.1984; S-3-11-1, S-3-13-5, isolated 31.I.1985 from stored soil collected 7.VII.1983. Living cultures deposited with ATCC; dried cultures and slides deposited in ILLS. **HOLOTYPE** (ILLS): A dried culture of paired isolates S-6-1-20 and S-6-4-9 containing perithecia at the interface of the two colonies.

Comments. *Chaetomium histoplasmae* is characterized by distinctive, tuberculate conidia closely resembling those of *Ajellomyces capsulatum* (Kwon-Chung) McGinnis & Katz (= *Histoplasma capsulatum* Darling). As in *H. capsulatum* the ornamented conidia seem to result from a process whereby cell wall material is blown out to form tubercles,

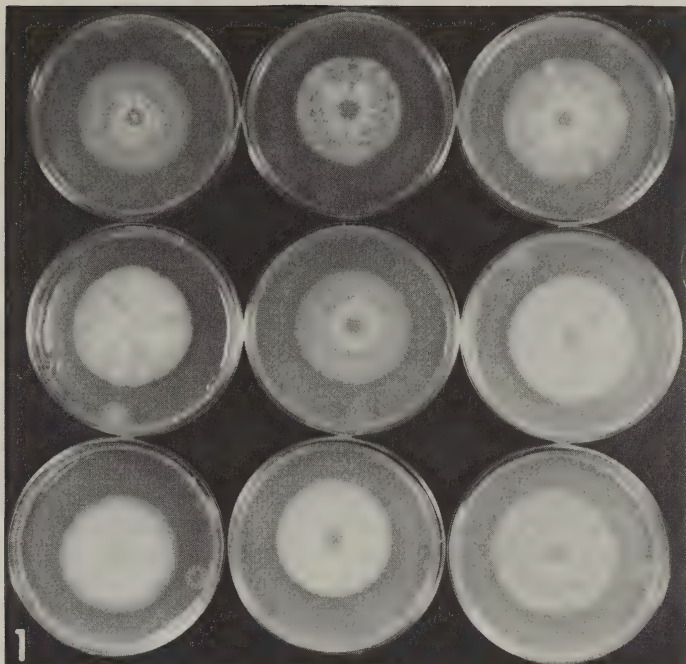


Fig. 1. Single ascospore isolates of *Chaetomium histoplasmoides*, X0.3.

possibly from minute channels in the thick conidial wall. In contrast to *H. capsulatum*, *C. histoplasmoides* forms only mycelial colonies at 37 C. According to current generic criteria the anamorph of *C. histoplasmoides* might be placed in *Chrysosporium* Corda (Carmichael, 1962), or, if one chooses to emphasize the taxonomic significance of the often somewhat swollen conidiogenous cells, in *Myceliophthora* Const. (van Oorschot, 1980). However, *Chrysosporium* sexual states generally belong to the Gymnoascaceae (Carmichael, 1962), and we are not convinced that conidiogenous cells in *C. histoplasmoides* are similar enough to those in *Myceliophthora* to justify placing the anamorph in that genus. We prefer not to name the anamorph of *C. histoplasmoides*.

Single isolates often produce structures resembling protoperithecial initials, composed of erect brown setae radiating from hyphal knots. When isolates were paired in various combinations on CMA (using either single conidia or

mycelial inoculum), 42% of 38 pairings resulted in incipient perithecia, usually in the region of contact between thalli, but mature perithecia with ascospores resulted in only 8% of the pairings. Attempts to stimulate more regular perithecial production on a variety of media, including CMA (Difco and home-made) and Weitzman-Silva-Hutner modified medium (Weitzman and Silva-Hutner, 1967) were unsuccessful. Colonies derived from single ascospores exhibited a range in morphology similar to that of the original isolates. Paired isolates from single ascospores failed to produce perithecia. The formation of fertile perithecia only in paired cultures, typically in the regions of contact between different colonies, suggests that the fungus is heterothallic. The inconsistent fruiting implies that nutritional or environmental conditions might also affect sporulation.

This species is somewhat similar to *Chaetomium piluliferum* Daniels (anamorph: *Botryotrichum piluliferum* Sacc. & March.). Both species produce perithecia with wavy to loosely-coiled hairs, morphologically similar ascospores, and cultures in which the anamorph is dominant. Comparison of *C. histoplasmae* with *C. piluliferum* (ATCC isolate 16221) confirmed that there are significant differences between the two species. *Chaetomium piluliferum* produced botryose clusters of smooth to faintly roughened, hyaline conidia (Figs. 16, 17, 19, 20) and aerial phialides that formed hyaline conidia 2-3 μ m in diameter (Fig. 18). *Chaetomium histoplasmae* differs from *C. piluliferum* in producing usually single, tuberculate, colored conidia, and in lacking a phialidic state. In addition, the perithecia formed by *C. histoplasmae* are one-half to one-third smaller than those described by Daniels (1961). Unfortunately, the isolate of *C. piluliferum* that was examined did not produce perithecia, and the type of this species is lost. Our observations on *C. histoplasmae* and *C. piluliferum* support the conclusions of Hawksworth (1975), who emphasized the value of anamorphic characters in separating taxa within *Chaetomium*.

Illinois Agricultural Experiment Station Project 68-0331, supported in part by the Illinois Soybean Program Operating Board. We thank Dr. D. P. Rogers for preparing the Latin diagnosis, Drs. D. Malloch and J. W. Rippon for helpful comments and suggestions, and Drs. Malloch and J. D. Rogers for reviewing the manuscript.

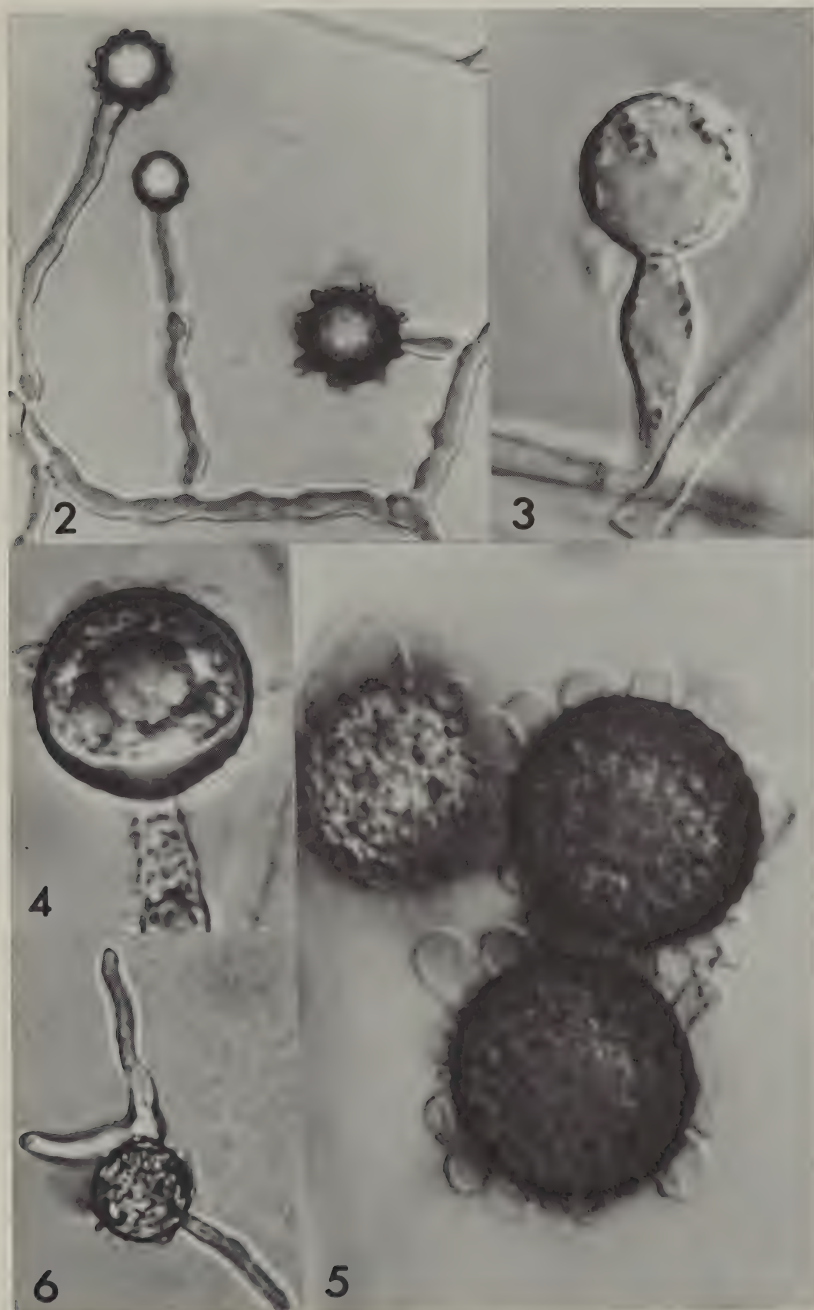
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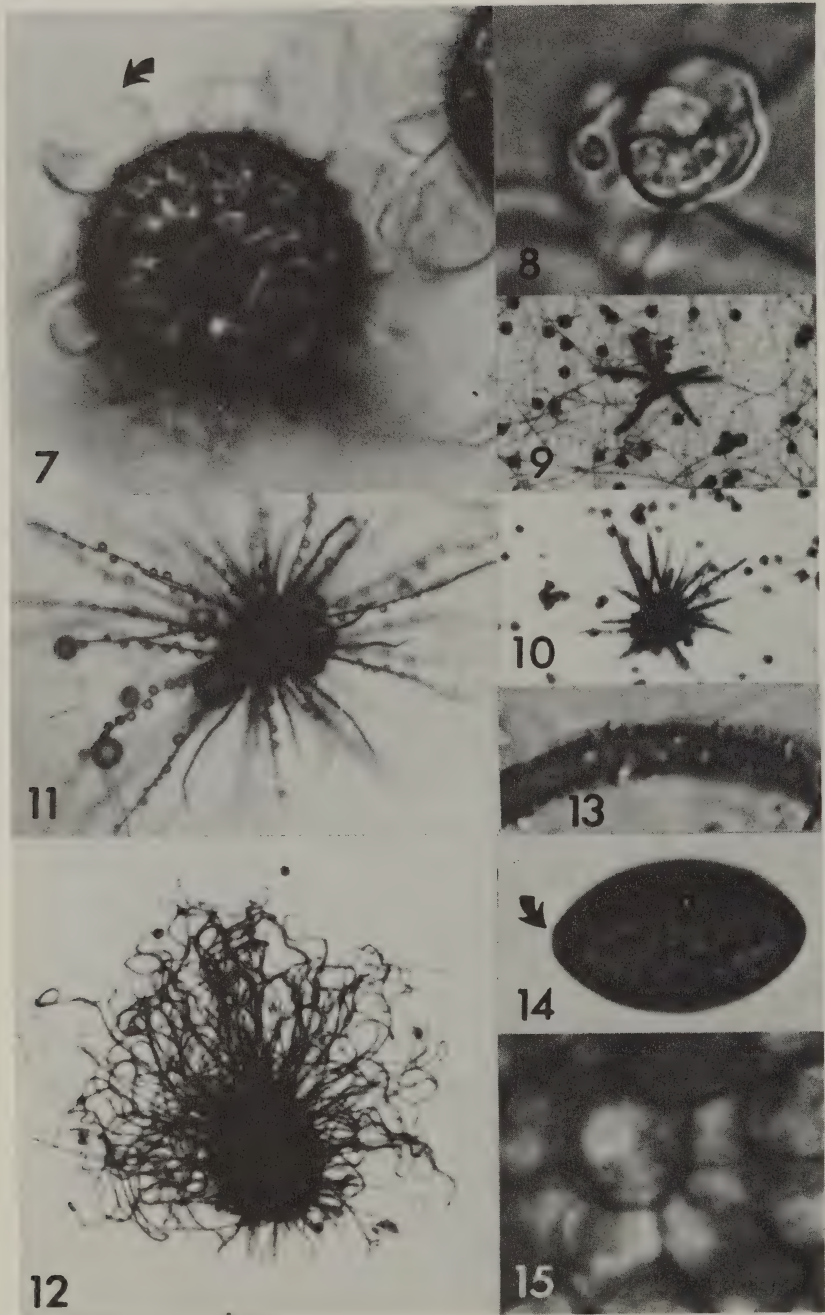
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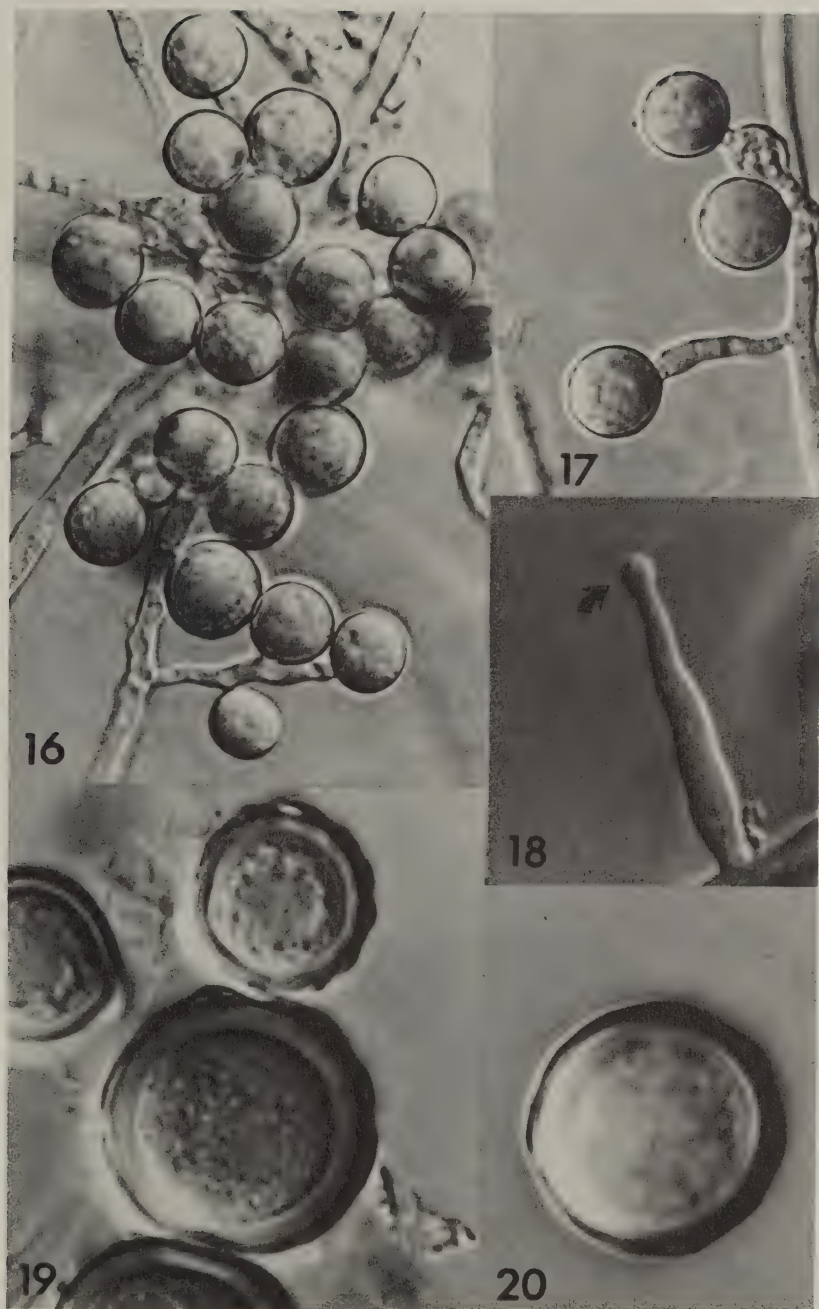
Figs. 2-5. **Chaetomium histoplasmae**. 2. Developing conidia, X780. Note single arrangement of conidia (as opposed to clustered conidia). 3. Immature conidium, X2090. 4. Maturing conidium, X2090. In comparison to previous figure note darker color and small tubercles beginning to develop from conidial wall. 5. Mature, dark conidia with well-developed tubercles, X2090. 6. Germinating conidium, X780.

Figs. 7-15. **Chaetomium histoplasmae**. 7. Mature conidium with large, thin-walled tubercles collapsing to become cupulate (arrow), X 2090. 8. Ascogonial coil-like structure from interface of two mated colonies, X2090. 9. Stellate cluster of mycelial hairs marking likely site of incipient perithecium, X60. Note numerous surrounding conidia (dark circular objects). 10, 11. Developing perithecia with conspicuous hairs, X50 and X100, respectively. 12. Mature perithecium, X100. 13. Portion of ornamented perithecial hair, X2090. 14. Ascospore with terminal germ pore (arrow), X2090. 15. Peridium, X835.

Figs. 16-20. **Chaetomium piluliferum**. 16. Botryose cluster of conidia, X600. 17. Conidia and conidiogenous cells, X600. 18. Phialide with developing spore (arrow), X2090. 19. Mature conidia with thick, ornamented walls, X2090. 20. Nearly smooth conidium, X2090.







NOTES ON SOME INOPERCULATE DISCOMYCETES IN JAMAICA

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ABSTRACT Fourteen species of inoperculate Discomycetes from Jamaica have been studied. *Unguiculariopsis ravenelii* is proposed as a new combination.

In December of 1986, a collecting trip to Jamaica was undertaken by R. P. Korf, T. Iturriaga, and W.-y. Zhuang. During this trip many interesting discomycetes were collected, and a few of them were cultured. This paper presents my studies on several inoperculate discomycetes (Leotiaceae). Although most of the specimens I examined are small, they represent some common and rare fungi distributed in that area.

1. *Ionomidotis olivascens* Durand

This fungus was found on *Hypoxylon jecorinum* on the cut surface of a fallen branchlet. The apothecia of this fungus are in a cluster, ear-shaped or unequal-sided, and the color of the hymenium and receptacle is very dark. The apothecium has a strongly ionomidotic reaction, the purplish brown pigmentation coming out of the excipular tissues not only in aqueous KOH solution but also slightly in water. Ascospores shot on PDA did not germinate. Sections of this fungus have been made. The anatomical structure as well as the measurements of asci and ascospores are those of *Ionomidotis olivascens*. Another fungus, *Ionomidotis frondosa* (Kobayasi) Kobayasi & Korf, has also been compared. As indicated by Korf, the type specimen of this species was lost, but authentic material (CUP-JA 387) had been studied by Kobayasi and Korf when the fungus was transferred from *Bulgaria* to *Ionomidotis* (Korf, 1958). My observation has shown that *I. frondosa* is closely related, and is associated with ? *Coniochaeta* sp.

2. *Lambertella aurantiaca* Tewari & Pant

This fungus is relatively common in Jamaica. Three collections (CUP-MJ 1114, 1134, 1151) have been studied. They occur on stems and

petioles of *Rubus ellipticus*. CUP-MJ 1114 has been cultured, and the fungus produces spermodochia, spermatia, and black, thin stromata abundantly on PDA (FIG. 1). Thorough studies of this species have been carried out by Tewari and Pant (1967) and Dumont (1971). Our culture is deposited in ATCC as #62912.

3. *Lambertella corni-marisi* Höhnelt

Only one apothecium was found, associated with a *Moellerodiscus* species (CUP-MJ 1152). The host is also *Rubus ellipticus*, which was a very common host for many different fungi on our trip.

4. *Lambertella* sp. #1

This fungus is different from any other species of this genus (Dumont, 1971; Korf & Zhuang, 1985). Only one specimen (CUP-MJ 1113) was collected. The apothecia of this fungus occur on rotting leaves of *Rubus ellipticus*, are stipitate, up to 2 mm in diam., with a hairy receptacle surface. The hairs on the receptacle have a pointed apex which recalls the hairs of *L. zeylanica*, but the asci and ascospores are too large to be that species (asci 95-105 x 7-8.5 μm vs. 44-60 x 5-6 μm , ascospores 11-14.5 x 4-5 μm vs. 5-9 x 2-3 μm). The measurements of asci and ascospores approach those of *L. tewarii*, but the hairs and excipular structure are not correct for this species. It may represent a new taxon. Since the only specimen does not have enough apothecia to serve as a type, I mark it "sp. #1" until an ample collection of this fungus is available.

5. *Lanzia rufo-cornea* (Berk. & Br.) Dumont

This is a worldwide distributed species, and common in Jamaica. Three specimens we collected (CUP-MJ 1004, 1048, 1139) are all on petioles. The number of apothecia in each collection is limited.

6. *Martininia panamaensis* (Whetzel) Dumont & Korf

This fungus (CUP-MJ 1126) was found on a decayed leaf. It has a long-stalked apothecium, brown, small ascospores and small asci, and agrees well with Dumont and Korf's description (Dumont & Korf, 1970).

7. *Moellerodiscus lentus* (Berk. & Br.) Dumont

Several collections of *Moellerodiscus* have been found during our trip. CUP-MJ 1034, 1035, and 1104 have been examined, and they are *M. lentus*. They occur on leaves, fruits and herbaceous stems of unidentified plants.

8. *Polydesmia dumontii* (Korf) Korf

One collection (CUP-MJ 1121) was found on leaf petioles of an unidentified plant. The apothecia of this fungus are white, and about 0.25 mm in diam when fresh. The hymenium is pruinose, the receptacle surface furfuraceous to woolly, and ascus 4-spored. The morphology of this fungus



FIG. 1. Stromata and spermodochia of *Lambertella aurantiaca*. a. surface view of culture; b. reverse of culture.

is identical with the description of *Polydesmia dumontii* (Korf, 1978).

9. *Polydesmia fruticicola* Korf

In the same collecting area we found another *Polydesmia* species (CUP-MJ 1125) on stem of *Rubus ellipticus*. It has smaller apothecia than CUP-MJ 1121 does, and matches well Korf's original description of *P. fruticicola*. Only three species of this genus have so far been reported in the world (Korf, 1978).

10. *Strossmayeria basitricha* (Sacc.) Dennis

This species (CUP-MJ 978) was also found on stems of *Rubus ellipticus*. The morphology of this collection is identical with the descriptions of this species given by Dennis (1978) and Iturriaga (1984).

11. *Strossmayeria* sp.

This fungus (CUP-MJ 980) was also collected on stems of *Rubus ellipticus*. Its morphology is quite different from that of *S. basitricha*. The ascospores are about $34.5\text{--}55.0 \times 6.0\text{--}7.3 \mu\text{m}$, and asci are $120\text{--}125 \times 18.5\text{--}20 \mu\text{m}$. It may be identical with *Gorgoniceps jamaicensis* (Seaver, 1951). My colleague, T. Iturriaga, is doing detailed work on this fungus for her forthcoming monograph of the genus *Strossmayeria*.

12. *Unguiculariopsis ravenelii* (Berk. & Curt.) Zhuang & Korf, comb. nov.

≡ *Peziza ravenelii* Berk. & Curt., *Grevillea* 3: 141, 1875.

≡ *Cenangium ravenelii* (Berk. & Curt.) Sacc., Syll. Fung. 8: 568, 1889.

≡ *Encoeliella ravenelii* (Berk. & Curt.) Höhn., Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 119: 619, 1910.

This fungus-inhabiting species has only been reported from North America before. During our collecting trip, we specifically looked for species of *Unguiculariopsis* on *Rhytidhysterium*, and found three collections (CUP-MJ 989, 991, 1017) on the expected host fungus. But this does not mean that *U. ravenelii* is a common species. The fungus occurs on the hymenium of the hysterothecia of *Rhytidhysterium rufulum*. The apothecia have an orange to brownish-orange hymenium, a furfuraceous, greyish to whitish receptacle surface, and are about 1-2 mm in diam. The host fungus on which *U. ravenelii* grows is not vigorous, and may be somewhat decayed. Ascospores of *U. ravenelii* were shot on PDA medium. They germinate after 24 hours. Germ tubes grow slowly, and the fungus hardly produces a colony on artificial medium even after a long time. Some of the germ tubes stop extending after a short growth period, and perhaps die later. The collections from Jamaica are identical with those from North America. This species has been synonymized with *U. hysterigena* (Höhn., 1910; Korf, 1971), but the types of *U. hysterigena* and *U. ravenelii* are distinguishable in hair morphology, excipular structure, and shape of apothecium. They should be recognized as independent species.

13. *Unguiculariopsis* sp.

The apothecia of this fungus were found on the fruitbodies of an old, long-beaked pyrenomycete. Some apothecia are seated right on the fine beak of the host. This fungus has the smallest apothecia and rather large asci and ascospores in comparison with other species of *Unguiculariopsis*. It may be new. Detailed work on this collection (CUP-MJ 1013) will be reported in my monographic study of the genus.

14. *Velutaria rufo-olivacea* (Alb. et Schw. : Fr.) Korf

One collection (CUP-MJ 1154) was found on stem of *Rubus ellipticus*. It is exactly as described by Dennis (1956) and Korf (1971).

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LUGOL'S SOLUTION/IKI VERSUS MELZER'S REAGENT: HEMIAMYLOIDITY, A UNIVERSAL FEATURE OF THE ASCUS WALL

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SUMMARY

Different iodine solutions or different pretreatments often produce strikingly different results concerning the two basic color reactions blue (b) and red (r). Rehydrating herbarium specimens in KOH irreversibly transforms many of the red reactions of ascocarp structures into a blue reaction (remove the alkali before applying the iodine). Every red reaction that shows this peculiar behaviour, is completely suppressed when Melzer's reagent is employed (or reagents containing lactophenol instead of chloral hydrate). The KOH-induced blueing, however, can be obtained in Melzer's reagent if the pretreatment is strong enough.

Red reactions which behave like this are termed hemiamyloid. The use of Melzer's reagent instead of IKI permits testing for this type of reaction only indirectly by comparing the reaction before and after KOH treatment, as e.g. KOHN & KORF (1975) did. Or, the red reaction can be obtained by putting a Melzer's-treated specimen in a drop of water in order to remove the clearing agent.

The true dextrinoid reaction does not differ in color but is obtained in both IKI or Melzer's reagent (or even exclusively in the latter) and does not turn blue by KOH pretreatment (but may be enhanced thereby and may turn blue by rinsing with water). Hence, both reagents should attain current use by workers.

Most hemiamyloid reactions occur in the hymenium, especially in ascus wall layers. In non-pretreated IKI mounts of hymenia, different iodine concentrations produce three main types of reaction: 1. solely red (type rr), 2. solely blue (type bb), 3. red at high, blue at low concentrations (type rb). Type "br" does not occur. Type bb is termed euamyloid; hemiamyloidity encompasses types rr and rb. Within type rb, there exist subtypes characterized by the critical concentration c_{rb} that marks the color change from blue to red. c_{rb} varies among species between 0.03 and 1 %. These characters are highly

consistent on species or genus level. Yet, categories are not sharply delimited from each other.

Workers are urged to use IKI (1% iodine, 3% KI) instead of Melzer's reagent for an easier and clearer diagnosis of hemiamyloidity. Evaluation of c_{rb} requires the use of a set of IKI reagents with gradually ascending I_2KI concentration within the range of 0.03 - 1% I_2 .

Hemiamyloidity occurs in hymenia of most Ascomycete orders and in excipula or ascospores of certain Ascomycetes (see appendix).

Hymenial amyloidity is hypothetically referred to the presence of highly elastic helical isolichenin molecules that are stretched during spore discharge. The KOH-induced blueing might rest on the transfer of straight into curled molecule segments.

ZUSAMMENFASSUNG

Unterschiedliche Jodlösungen oder Vorbehandlungen führen oft zu stark abweichenden Resultaten in den beiden wichtigen Farbreaktionen blau (b) und rot (r). Aufquellen von Herbarmaterial in KOH überführt viele der rot reagierenden Strukturen des Ascocarps unumkehrbar in eine blaue Reaktion (hierbei muß die Lauge vor Jodzugabe entfernt werden). Jede Rotreaktion mit diesem besonderen Verhalten wird in Melzer's Reagens völlig unterdrückt (auch in Reagentien, die anstelle von Chloralhydrat Lactophenol enthalten). Die durch KOH induzierte Blaureaktion kann jedoch auch in Melzer's Reagens erhalten werden, falls genügend stark vorbehandelt wurde.

Rotreaktionen mit diesem Verhaltensmuster werden hier "hemiamyloid" genannt. Wird Melzer's Reagens anstelle von JJK gebraucht, muß die Diagnose indirekt erfolgen, indem die Reaktion vor und nach KOH-Behandlung verglichen wird, wie z.B. KOHN & KORF (1975) vorgingen. Oder man kann die Rotreaktion mit diesem Reagens auch erhalten, indem man die damit behandelte Probe in einen Tropfen Wasser bringt, um das Aufhellungsagens zu entfernen.

Die echte Dextrinoidreaktion zeigt die gleiche Farbe, kann aber in JJK wie in Melzer's Reagens (oder sogar nur in letzterem) erhalten werden und wird durch KOH-Behandlung nicht in blau überführt (jedoch manchmal verstärkt; Spülen mit Wasser kann Blaufärbung hervorrufen). Beide Reagentien sollten deshalb einen festen Platz in der Chemotaxonomie höherer Pilze erhalten.

Die meisten Hemiamyloidreaktionen kommen im Hymenium und besonders in Schichten der Ascuswand vor. Unterschiedliche Jodkonzentrationen erlauben die Unterscheidung von drei Haupttypen von Reaktionen in nicht-vorbehandelten JJK-Präparaten von Hymenien: 1. nur rot (Typ rr), 2. nur blau (Typ bb), 3. rot bei hohen, blau bei niedrigen Konzentrationen (Typ rb). Typ "br" existiert nicht. Typ bb wird hier "euamyloid" genannt, während die Typen rr und rb der Hemiamyloidreaktion angehören. Innerhalb des Typs rb können Subtypen unterschieden werden anhand der kritischen Konzentration c_{rb} , welche den Farbwechsel von blau nach rot markiert. Diese kann je nach Spezies zwischen 0.03 und 1% liegen. All diese Eigenschaften sind hochgradig konstant auf Art- oder Gattungsebene. Die Kategorien sind je-

doch nicht scharf voneinander getrennt.

Es wird dringend geraten, JJK (1% Jod, 3% KJ) anstelle von Melzer's Reagens zu verwenden, um Hemiamyloidität leichter und eindeutiger zu diagnostizieren. Zur Ermittlung von c_{rb} wird ein Set von JJK-Lösungen mit gleichmäßig ansteigenden J_2KJ -Konzentrationen im Bereich von 0.03 - 1% J_2 benötigt.

Hemiamyloidität findet sich in den Hymenien der meisten Ordnungen der Ascomyceten, sowie im Gehäuse und an Ascosporen gewisser Ascomyceten (siehe Anhang).

Amyloidität im Hymenium wird hypothetisch auf hochelastische helixförmige Isolicheninmoleküle zurückgeführt, die beim Sporenausstoß gedehnt werden. Die durch KOH induzierte Bläuung könnte auf der Überführung gerader in schraubenförmige Abschnitte beruhen.

INTRODUCTION

Iodine solutions are one of the most frequently used chemical reagents in both mycology and lichenology. Iodine is able to produce color "reactions" involving the formation of blueish ("amyloid") and reddish ("dextrinoid") complexes.¹ The reactive substance may be located in the cell plasma, the cell walls, or the intercellular excretions.

In his preliminary studies on the chemotaxonomy of both lichens and free-living fungi, NYLANDER (1865) was the first (HAWKSWORTH et al. 1983:198) who found blueing in iodine a consistent and highly useful feature.² Nevertheless, several Discomycete workers of the 20th century have neglected or inconsequently employed the iodine test (e.g. SEAVER, GROVES, WHITE, WHETZEL, BOUDIER, LEGAL, VELENOVSKY). A similar divergent attitude against the iodine test exists among lichenologists. Careful studies of the recent decades (e.g. KORF 1962, KOHN & KORF 1975, NANNFELDT 1976, DÖBBELER 1978, POELT & VĚZDA 1977 & 1981, KILIAS 1981) leave no doubt about their extraordinary taxonomical importance.

Metallic iodine (I_2) is very difficultly to dissolve in pure water (0.03% at 20°C). Since optimal reactions are obtained at iodine concentrations between 0.1 and 1%, varying amounts of ingredients (usually KI) have been added to improve its solubility. For the purpose of an improved preparation technique or a clearer reaction, many workers have added high amounts of clearing agents to the solution. Accordingly, numerous formula of iodine reagents are in use even today. The present study gives evidence of strikingly different results when such different reagents are employed.

1) BONNER (1950:49/50) considered the intense blueing of amylose an iodine complex being formed by taking up iodine stoichiometrically. Likewise, GREENWOOD & EARN-SHAW (1984) explained the "dramatic dependence of color on the solvent" (reddish-brown/pink or violet) by a "weak donor-acceptor interaction leading to complex formation between the solvent (donor) and I_2 (acceptor) which alters the optical transition energy" (:941). Yet, SINGER (1975:95) took iodine reactions to happen "rather by absorption than by fully measurable chemical transformations of the treated (fungal) material" and drew attention to the inaccuracy of using the word "reagent".

2) The element (I, German: J) was discovered in 1812.

THE HEMIAMYLOID IODINE REACTION — A HISTORICAL REVIEW

KOHN & KORF (1975) discovered that there exist two kinds of amyloidity of the apical ring of Helotiales-asci: the non-pretreated (direct) blueing, and the provoked/induced blueing being caused by pretreatment with potassium (or sodium) hydroxide = KOH (NaOH). The provoked blueing is said to be characteristic of every studied species of the genera Pezicula, Dermea, and Chloroscypha. Such alkali-inducible reactions were already observed by MINKS (1881, Pezicula spp.), O. ERIKSSON (1966, Hypoxyton serpens¹), KÖHLER (1968, Trapelia coarctata etc.) and B. ERIKSSON (1974, Arwidsonia empetri)². Several recent workers (e.g. NANNFELDT 1976) confirmed KOHN & KORF'S observation and found the provoked blueing to occur within additional genera (see appendix). Yet, others might have doubted its importance since they have neglected it in their descriptions (e.g. DENNIS, GRADDON, SVRČEK, RAITVIIR).

On the other hand, workers have distinguished between blueish and reddish reactions of the apical ring, the whole ascus wall or the hymenial gelatine since the time the reagent had been introduced (e.g. NYLANDER and ARNOLD, notes on their herbarium labels, according to KILIAS 1981:258). Contrary to the provoked blueing, reddish reactions have been reported much more frequently to be characteristic for many species or genera of both lichenized or free-living Disco- or Pyrenomycetes (see appendix). However, some lichenologists doubted its taxonomical value (MINKS 1881:LIX, TOBLER 1925:114) because blue and red reactions actually occur not rarely in the same preparation due to different iodine concentrations within it. Lichenological compendia as A. L. SMITH (1921), HENSSEN & JAHNS (1974), or HALE (1983) even ignore the red reaction.

Thus, it seems there exist three kinds of reactivity: (1) blue, (2) red, (3) negative but blue when pretreated by KOH. It should be noted, however, that those authors who reported the provoked blueing used iodine reagents that contain high amounts of clearing agents (TAB. 1), whilst those authors who reported reddish reactions (mainly lichenologists) used pure Lugol's solution/IKI (if they mentioned the reagent at all). Moreover, the "Melzer-mycologists", as I will call the first group inaccurately, obviously have never reported reddish reactions that explicitly refer to ascus walls/apical rings: NANNFELDT (1976: 284) and KORF (oral comm.), being aware of the literature reports of the reddish reactions, wondered why they were not able to get them.

Furthermore, several workers have reported a KOH-induced change in iodine reactivity from red to blue (using IKI) for ascus walls or hymenial gels of mainly lichenized or bryophile fungi (see later). Some lichenologists take only the blue reaction for "J+" and therefore urge to pretreat specimens consequently by KOH before applying IKI (the iodine test is often used only for making ascus structures better visible). Yet, KILIAS (1981) emphasized not to rehydrate lichens in KOH

1) Authors citations of species names are omitted in all cases in which they appear in the appendix.

2) MINKS, followed by O. & B. ERIKSSON, employed an acid treatment between alkali that turned out to have no influence on the mentioned effect.

in order to recognize the characteristic red reaction.

In the course of my work on Helotiales over the past 13 years I soon became familiar with reddish reactions of apical rings and found this feature to be characteristic of certain genera, e.g. Lachnellula, Allophylaria, and Pezicula (BARAL 1984, BARAL & KRIEGLSTEINER 1985). I was unable, however, to name a single species that showed the feature published by KOHN & KORF (I failed to note that these authors had treated the same genus: Pezicula). The reagent I have used was IKI (ca. 0.2% iodine), not Melzer's reagent as I stated erroneously in the mentioned literature.

Unpublished research undertaken with WALTER MATHEIS and PAUL BLANK in November 1985 accidentally led to the discovery that an Allophylaria sp. did not at all stain red (as I expected) but rather J- when we used a correct Melzer's reagent. However, it displayed strongly red-brown apical rings when we used Lugol's solution. Accordingly, a J+ reaction was not observed in this species if Melzer's reagent was employed. This suggested (MATHEIS' idea) testing a KOH pretreatment, and indeed, the apical rings turned deep blue in Melzer's reagent as well as in Lugol's solution.

Consequently, I have examined nearly 100 available Ascomycete-species including ca. 30 lichens that all showed a $\pm$ red-brown IKI reaction in at least one hymenial element (apical apparatus, ascus wall, or ascus gel), and have found them all to behave this way: $\pm$ negative in Melzer's reagent, and blue after (strong) KOH pretreatment in either IKI or Melzer's reagent. Many species' structures that react directly blue have been tested in comparison: None of them was J- in Melzer's reagent (except for tholi of Lecanorales) but some showed enhancement of a faint blue Melzer's reaction when pretreated by KOH.

It turns out that there are only two main types of amyloidity in structures of the ascus wall, the red reaction being synonymous to the feature published by KOHN & KORF. Since there seem to have never been made attempts to introduce terms for these two types, this is done in the present study: The blue reaction obtained directly without pretreatment in IKI (1% I₂, 3% KI) is here called euamyloid. The term "pseudodextrinoid" was proposed in an unpublished manuscript (BARAL 1986:19) for the reddish reaction in IKI (ca. 2% I₂, 6% KI). It is here changed into hemiamyloid (i.e. halfway to being euamyloid), a term proposed by Prof. R.P. KORF (in litt. 19.2.86). Hemiamyloidity turned out to occur in most Ascomycete orders with a positive iodine reaction in microstructures of the ascus (see TAB. 6).

The shade of the red hemiamyloid reaction in all these taxa varies from pink-red or salmon-colored to purplish-red, violet-red, red-brown, or orange-brown, often with a dirty greyish tint. The following literature reports will exemplify this color reaction:

Helotiales: KARSTEN 1869:105: "thecae apice ultimo iodo obsoletissime violaceo-fuscescentes"; REHM 1896, 1912: "Jod färbt den Schlauchporus (sehr auffallend/schmutzig) violett"; CHADE-FAUD 1942:67: "l'iode colore les anneaux amyloides non pas en bleu, mais en violet pourpre"; BELLEMÈRE 1967: "anneaux api-

caux ... amyloides, mais colorés en brun-orangé, pourpre-orangé par l'eau iodo-iodurée"; DÉFAGO 1967: "leur sommet ... contient un foramen qui se colore au lugol en violette, rose ou bleue, violet rouge clair, rouge brun, bleu rouge, bleu violet"; HEIN 1976:16: "Die Jodfärbung (Lugol) kann blaßgrauosa, schmutzigviolett, milchigblau oder schwarzviolett sein".

Lecanorales: BRODO 1973:265: "... with IKI solution turning deep red-orange immediately, with no trace of blue".

Arthoniales: REDINGER 1937: "Hymenium mit Jod weinrot".

Dothideales: DÖBBELER 1978:12: "... Hymenialgallerte rötlich ... Der Farbton wechselt von meist lachsrot bis orangerötlich oder bräunlich".

It appears almost unconceivable to me that the suppression of a red reaction by Melzer's reagent has never been reported before 1978 though this type of reaction occurs quite frequently, as stated above. Even NANNFELDT (1976:283) believed that there are no indications of differing results among different iodine solutions. Only very recently, my attention was drawn by Prof. J. POELT to Dr. P. DÖBBELER's (1978 ff.) observations. DÖBBELER seems to be the only author who has reported that red reacting hymenial gels or ascus wall layers fail to react in Melzer's reagent. This important discovery obviously has reached no further popularization in the last years (though ROSSMAN 1980 drew attention to it) because it was obtained from bryophile Pyrenomycetes, a quite rarely studied subject. The suppression of red reactions in lichen hymenia in Melzer's reagent seems to be a non-published common experience that led lichenologists to abandon the use of that reagent.

REPORTS OF DIFFERENT TYPES OF HEMIAMYLOIDITY

A more thorough investigation using IKI with different iodine concentrations (TAB. 2) revealed that a lot of species being J- or nearly so in Melzer's reagent, show both blue and red reactions without being pretreated ("rb-species"). The red reaction always appears at higher, the blue at lower concentrations.

Category rb is quite often reported in the literature, mostly from orders in which the "whole hymenium" is reactive. In sections mounted in water, addition of iodine solution produces first a blue reaction turning quickly red due to a delayed infiltration by iodine. When employing IKI with an iodine titre slightly above the critical value, these sections may show the whole spectrum of color simultaneously like a rainbow: The blue and red regions form two rather broad stripes separated from each other by a greenish-yellowish zone. This zone moves within ten or so seconds from the top to the base of the asci.

E.g. REHM (1896) and ZSCHACKE (1934) already distinguished carefully among the types rr, rb, and bb.¹ The following literature reports exemplify the rb-type of reaction:

REHM 1896: e.g. 322-326: "Jod färbt die Fruchtschicht vorübergehend blau, dann weinrot" (Scutula spp.). ZSCHACKE 1934: "Der Kern wird durch Jod nach vorübergehender Bläuung weinrot gefärbt" (Verrucaria spp.). VELENOVSKÝ 1934:76: "... jodo coerulea dein rubella" (Scutula epiblastematica). VĚZDA 1968:374: "Asci et gelatina hymenialis J caerulescens, dein rubescens" (Thelopsis spp.). POELT & VĚZDA 1977: e.g. 173: "Hymenium mit zwei Haupttypen von J-Reaktionen: J+bleibend tiefblau oder J+grünlich-blau sofort braunrot" (Pannaria spp.). DÖBBELER & TRIEBEL 1985:511: "Gallerte zwischen den Asci (schmutzig) rotbraun, der Färbung wandert eine hellblaue Zone voran" (Dactylospora heimerlii).

FÜSTING(1868) even emphasized distinction among different subtypes of type rb. He obtained the color change from "indigo-blue" to "red-violet/wine-red/red-brown" either in water plus iodine crystals (Thelidium spp.) or only by use of IKI (Verrucaria schaeeri). While FÜSTING thought the presence of potassium iodide essential for the second red reaction, TOBLER(1925:114) and POELT (in litt. 18.7.86) took these effects for merely a matter of iodine concentration.

TOBLER thought the phenomenon "rb" to exist in every lichen species with a reactive hymenium (he had tested more than 100 species) concluding that it deserves no taxonomical regard. I have tested only ca. 30 lichenized species and have found all of them to show a hemiamyloid reaction in the hymenium (except a Diploschistes that was entirely inamyloid), mostly of type rb, yet type bb often accompanies type rb in separate microstructures. Two species showed type rr (Arthonia, Verrucaria).

The existence of these three main types of amyloidity in lichen hymenia is a well-known fact to Prof. J. POELT and Dr. J. HAFELLNER (pers. comm.), yet it is little understood. Repeatedly, lichenologists have intended a detailed investigation on this topic (POELT, pers. comm.; KILIAS 1981:260).

TOBLER (l.c.) specified the critical iodine concentration (c_{rb}) to lie at ca. 1%. My comprehensive tests revealed it to lie always within the range of 0.03 - 1% in all Ascomycete orders tested here.

REPORTS OF INDUCED BLUEING OF RED REACTING STRUCTURES

The alkali-induced blueing of red reacting apical rings seems to be a completely unknown property within the Helotiales. Some reports exist for the "hymenial" gelatine and/or the ascus wall of lichens (the

1) The fact that the critical concentration (c_{rb}) varies strikingly among the species results in the complication that workers have reported only those red reactions that appear beyond that iodine concentration of the employed IKI solution. Therefore, e.g. HAFELLNER (1979) who is used to employ IKI with ca. 0.06% I_2 , noted blue reactions for Dactylospora rimulicola, D. stygia and Buellia punctata, (but red in others), whereas REHM (1896) noted "rb" (see appendix). On the other hand, workers who have reported a red reaction might have neglected the blue at low concentrations.

authors obtained the reaction mostly - except KUROKAWA - without an acid treatment between KOH and IKI, contrary to MINKS and O. & B. ERIKSSON):

HUE 1904: Lepolichen granulatus (according to NANNFELDT 1976), R. SANTESSON 1952:89: Arthonia calamicola; KUROKAWA 1969:689: Pyrenula punctifera, many spp. of Lecanactis; DÖBBELER 1978:12/13, 1979, 1981:404, 1983, 1984, 1985: mainly bryophile Dothideales; HAFELLNER 1979:29/182: Karschia santessonii; POELT & VĚZDA 1981:162: Hymenelia spp., :335: Tremolecia atrata; KILIAS 1981: 254/410: many spp. of Catillaria; HONEGGER 1982:215: Coccotrema cucurbitula, Trapelia coarctata; SCHEIDEGGER 1985:200: Trapelia coarctata.

The rareness of such observations reported often only for one single species misleads to think that there are also red reacting ascus wall layers or gels that do not turn blue when KOH-pretreated. Yet, especially DÖBBELER's reports indicate the universal occurrence of the effect: This author has shown that each of the ca. 50 species of bryophile Dothideales that showed a red IKI reaction of the hymenial gel, displayed a blue gel reaction if KOH-pretreated. DÖBBELER (1981:404) observed this phenomenon also in excipular regions of a few species.

Though these authors (1978 ff.) knew of the publications of KOHN & KORF (1975) and NANNFELDT (1976), they thought the KOH-provoked blueing of apical rings of Helotiales to belong in a different category. Therefore, e.g. HAFELLNER (1984:250) searched for that category without success (using IKI), stating that inamyloid asci showed no basic change in reactivity when KOH-pretreated. Likewise, NANNFELDT knew of the reports of HUE and KUROKAWA, yet this did not give him the idea to try it with an IKI solution.

ROSSMAN (1980) drew attention to DÖBBELER's observations of red reactions (incorrectly citing "red droplets" instead of "red reacting amorphous gel", DÖBBELER in litt.). Likewise, ROSSMAN emphasized the use of IKI in favour of Melzer's reagent to avoid contradictory statements, since mycologists and lichenologists have begun to "interact".

Contrary to my observations, both authors found even the KOH-inducible blueing to be absent in Melzer's reagent in every studied species of those Dothideales (DÖBBELER in litt. 29. 7. 86). Therefore, DÖBBELER believed his observations belong to a separate type of reaction. I studied a single species of this group, Epibryon muscicola, which I kindly received from DÖBBELER, and found a distinct KOH-induced blueing in Melzer's reagent. Later, I discovered by accident, that the provoked blueing in IKI is ?always induced by a distinctly lower KOH-concentration already, compared with the one obtained in Melzer's reagent. This was highly evident in Epibryon and Ostropales (TAB. 5). DÖBBELER has actually treated with ca. 2 - 5 % KOH for some seconds only whereas I have boiled the KOH-mount till all the water was evaporated.¹ Furthermore, DÖBBELER applied the Melzer's reagent to the KOH-mount without rinsing with water before-

hand (also the IKI, DÖBBELER 1978:12).

Accordingly, there seems to exist in the literature no report of the complete properties of the hemiamyloid type of reaction for any Ascomycete order encompassing (1) "rr" or "rb" in IKI, (2) J- or faintly blue in Melzer's reagent, and (3) "bb" after KOH pretreatment in IKI and blue in Melzer's reagent. Comparison among the works of "Lugol-" and "Melzer-mycologists" would, however, have allowed detection of this as yet unknown correlation for several Helotiales-genera: E.g. KOHN & KORF (1975) reported the necessity of KOH pretreatment for a J+ reaction in all examined Pezicula-species, whilst REHM (1896) reported for most species of that genus (included in Dermatea) a "violet" reaction (this refers with certainty to a purplish-red reaction). However, REHM did not mention the employed reagent formula. Such "indirect" reports for the correlation of the properties of hemiamyloidity are e.g.: Helotiales: Dermea spp. (KOH & KORF), Belonidium leucostomum (HUHTINEN), Lachnellula occidentalis (NANNFELDT), Urceolella hamulata (KORF & KOHN), Myriosclerotinia sulcatula (SCHUMACHER & KOHN); ?Rhytismales: Arwidssonia empetri (B. ERIKSSON) (see appendix; REHM reported for all of them the "violet" reaction while recent authors - in brackets - observed the induced blueing, mainly in Melzer's reagent). Reports for Xylariaceae (Hypocopa spp., Hypoxylon serpens) also indicate for this correlation.

THE IODINE REAGENTS

The following table treats most of the various iodine solutions employed as a microchemical reagent by ancient or recent workers.

Most of these solutions have in common to contain potassium iodide (KI) to render possible complete dissolution of the metallic iodine. The term "Lugol's solution" should be used only in its probably original sense: The formula is mentioned e.g. in ROSSMAN (1980) and MATHIAS (1972), and employed by MERCK (Nr. 9261, oral comm.). The reagent is chiefly in use by botanists and lichenologists. Deviations from it should probably better be called "IKI" (German: JJK), or more exactly "I₂KI" (if no further ingredient is added). Within IKI, the amount of KI varies considerably among the formulae: The range is from half to triple and more of the iodine titre. Some lichenologists (KÖHLER, MINKS) used a very high KI titre (10-20%).

The botanist A. MEYER introduced the use of chloral hydrate : water = 5 : 2 (1883:29), and "Chloraliod" by adding iodine crystals to the former to saturation (?1883, 1907:206). His objective was to dissolve plasmatic enclosures for an improved transparence of the preparation when staining minute starch grains in chloroplasts. Probably inspired by MEYER, MELZER (1924) introduced a very similar reagent for

1) SHERWOOD (1977:6) unfortunately abandoned rehydration in KOH in her studies on Ostropales. E.g. REHM (1896:159) states Cryptodiscus pallidus is an rb-species. SHERWOOD observed an inconsistent faint blue Melzer's reaction in this species, but I am sure she would have obtained a clear blue if she had pretreated strong enough.

TAB. 1. Iodine reagents employed by mycologists (m), lichenologists (l), and botanists (b). §: la = lactic acid (85% aqueous); lp = lactophenol (phenolic acid 1 gm, glycerin 2 gm, lactic acid 1 gm, water 1 gm); ch = chloral hydrate; et = ethanol. Proportions are declared in weight.

	author	reagent	I ₂	KI	H ₂ O	ch	§	et	I ₂ (%)
"Lugol-mycologists"	Hafellner (l)		1	2	1800	-	-	-	0.055
	Bertsch, Wirth (l)	JJK	1	3	500	-	-	-	0.2
	Oberhollenzer & Wirth, Rossman (l, m)	Lugol's (Merck)	1	2	300	-	-	-	0.33
	Degelius (l)		1	6, 3	167	-	-	-	0.58
	Matheis (m)	'Lugol's'	1	2	150	-	-	-	0.65
	Meyer, Ziegenspeck (b)	JJK	1	0.5	100	-	-	-	1.0
	Rossman (m)	IKI	1	1	100	-	-	-	1.0
	Hein (m)	'Lugol's'	1	2	100	-	-	-	1.0
	Döbbeler (m)	'Lugol's'	1	3	100	-	-	-	1.0
"Melzer -"	Tobler (l)	Jodtinktur	?	-	-	-	-	x	?
	Köhler (l)		var.	-20%	x	-	-	-	0-1.7
	Minks (l)		1	60	600	-	-	10	0.15
	Meyer (b)	Chloraliod	sat.	-	x	2.5x	-	-	?
	Melzer, Kohn & Korf, Matheis, etc. (m)	Melzer's	1	3	40	40	-	-	1.2
	Rossman (m)	'Melzer's'	1	3.3	66.7	66.7	-	-	0.73
	Nannfeldt (m)		?	-	-	-	lp	-	?
	Tobler (l)		?	-	-	-	la	x	?

staining the ornamentation of Russula-spores. Most mycologists later adopted "Melzer's reagent" by using either MELZER's original formula or deviations from it. The original formula was employed by KOHN & KORF, and in the present study. The formula mentioned by ROSSMAN (1980) has a considerably lower iodine titre; this is the "Langeron's modification" (HAWKSWORTH et al. 1983:365).

SINGER(1975:95) claims the reagent to be applied in an exactly circumscribed manner, that is: pretreatment in concentrated ammonia (NH₄OH) for a few seconds. Some workers removed excess iodine by washing the Melzer's-treated material repeatedly with aqueous chloral hydrate solution (e.g. IMLER 1950:178, when treating Boletales-hyphae).

NANNFELDT (1976:284), however, preferred the use of iodine in lactophenol instead of Melzer's reagent in most of his studies. Likewise, TOBLER (1910) emphasized the use of lactic acid by adding it to mounts in alcoholic iodine solution: the latter is said to show a reaction sometimes only within days (!) whereas adding lactic acid would lead to immediate results.

MATHEIS (1972:42/43) gives an account of the advantages of adding chloral hydrate to the IKI. The main advantage seems to be getting a clear preparation by homogenizing nearly everything that is no cell wall. This is mainly of importance with herbarium specimens, accor-

ding to my experience. Further advantages mentioned by MATHEIS are: (2) reduction of evaporation, (3) increase of viscosity (important for photomicrography), and (4) improvement of iodine intake into the cell wall. The latter is not true for IKI since this reagent gives always immediate reactions in full strength. (Yet, I recently discovered one type of "dextrinoidity" (*Mycena-trama*) that requires presence of chloral hydrate for a positive reaction).

KÜHNER & ROMAGNESI (1974:492) noted that collapsed cells of dried material become inflated in Melzer's reagent. This is true to a certain degree. However, if the reagent is applied to living specimens, cells are killed immediately, loose turgor, and shrink considerably thereby. Therefore, I use to employ Melzer's reagent rather for inducing shrinkage than inflation. (The universally occurring effect of shrinkage caused by the loss of turgor is nearly unknown to both mycologists and lichenologists. It gives rise to a lot of morphological changes and misunderstandings and I intend to treat this topic in a separate paper in this journal.)

Several more recent workers, mainly from Europe, have persisted in their use of IKI in spite of the mentioned advantages of Melzer's reagent: DÉFAGO (1967), BELLEMÈRE (1967), PARGUEY-LEDUC (1977), Prof. J. POELT's students HEIN (1976) and DÖBBELER (1978 ff.), and most lichenologists.¹ ROSSMAN (1980) drew attention to this "difference in basic methodology" between mycologists and lichenologists.

The differently concentrated IKI solutions employed in the present study contained always the triple amount of KI (if not otherwise stated). Though I knew of the high-grade volatility of iodine (I_2) and its disposition to degrade with time by forming HI (ZIEGENSPECK 1925:304/312, ROSSMAN 1980), I was highly surprised when I realized that my solutions had severely decreased in I_2 concentration within a few weeks (kept in 10 ml - phials of brown glass with rubber pipettes). A photometric test revealed the daily loss of I_2 to lie at ca. 0.005 - 0.01 %. Evaluation of c_{min} and c_{rb} was therefore done with fresh solutions not older than ca. two days. These can repeatedly be prepared by diluting a solution of high strength (3.1 %) with water. Dilution was carried out as follows:

- 3.1 %: 0.96 gm I_2 , 2.88 gm KI, 30 gm H_2O (S_1)
 - 6.6 ml of S_1 are needed for preparing the three stronger solutions
 - (1) 1.0 %: 3 ml S_1 , 6.5 ml H_2O
 - (2) 0.56 %: 1.6 ml S_1 , 7.4 ml H_2O
 - (3) 0.32 %: 2 ml S_1 , 18 ml H_2O (S_2)
 - 10.6 ml of S_2 are needed for preparing the four weaker solutions
 - (4) 0.18 %: 5 ml S_2 , 3.9 ml H_2O
 - (5) 0.1 %: 3 ml S_2 , 6.5 ml H_2O
 - (6) 0.056 %: 1.6 ml S_2 , 7.4 ml H_2O
 - (7) 0.032 %: 1 ml S_2 , 9 ml H_2O

1) The lichenologist DUNCAN (1970:XLII) employed both IKI and Melzer's reagent, the latter for clearing ascocarp details, for ascertaining presence of "isolichenin" in the medulla of e.g. *Lecidea confluens* (WEBER) ACH., and for the purplish reaction in the spore wall of *Graphis* etc.

Chloral hydrate is also said to degrade with time (in aqueous solution, MATHEIS 1972). Some workers (e.g. MOSER 1978:5) therefore add its crystals to the IKI solution only on the slide. Yet, I was not able to find any change in the properties of this substance when testing specimens with some up to four-years-old Melzer's solutions.

LOCATION OF THE HEMIAMYLOID REACTION

Most hemiamyloid reactions observed occur in hymenia, either in layers or apical organelles of the ascus wall, or in the "hymenial gel". Rarely, gelatinous excretions (? and cell walls) of ectal excipula or of ascospores may react hemiamyloid (see appendix).

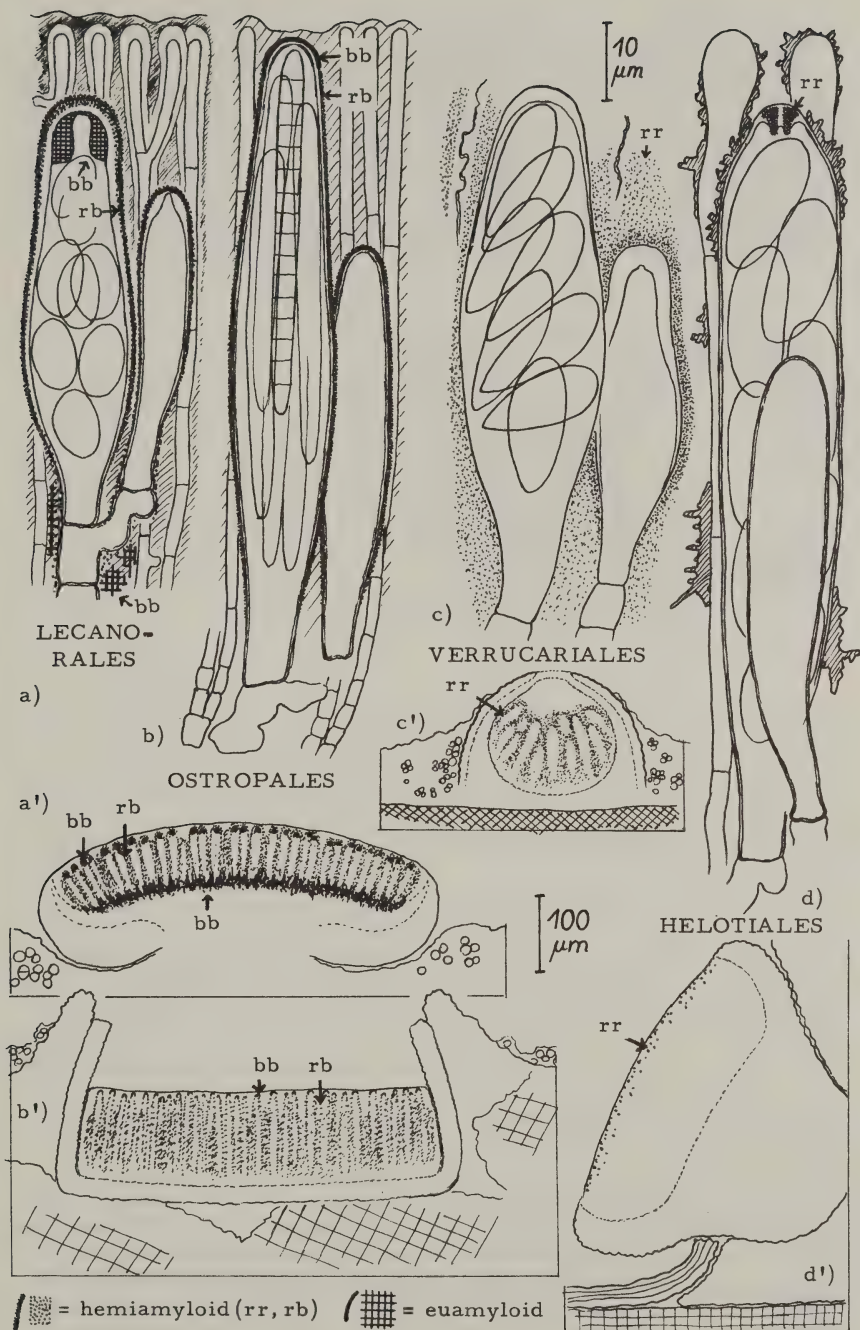
At this time, I am inclined to postulate amyloidity in hymenia to be exclusively produced by the dicaryotic mycelium (subhymenium: ascogen hyphae, hymenium: asci) in all Ascomycete orders. This was already emphasized by DEBARY (1866:282) for Lecanorales. (Many cursory reports for lichens mislead to consider the whole hymenium reactive.) Some workers (ZIEGENSPECK 1926:367/Taf. 12, *Cetraria islandica* (L.) ACH., KÖHLER 1968:25, POELT, HAFELLNER - pers. com.) claimed the paraphyse gel in certain Lecanorales to be also reactive. This is not confirmed here with the studied material (FIG. 2).¹

DÖBBELER (1978:12) assumed the red (hemiamyloid) reacting gel in bryophile Dothideales to be probably produced by the dissolving paraphysoids. The latter feature is said to be strikingly correlated with the red IKI reaction in all the many species he had studied, whereas those species with persistent paraphysoids were always J-. Some asci of the reactive species are said to simulate a reactive outer layer due to deposition of the gel on its surface. This gel is said to form a coherent mass when pressed out of the ascocarp (DÖBBELER 1979:193).

I detected comparable properties (coherent gel, some of the asci with reactive surface) in "*Cryptodiscus*" *rhopaloides* (Ostropales) and *Verrucaria* ?*floerkeana* (Verrucariales). I am inclined to conclude, however, that the reactive gel is produced by the (very) young asci because these were distinctly covered by this gel whereas the ripe asci usually appeared non-reactive (FIG. 1, c). A species probably closely related to the former, ?*Karstenia loniceræ*, showed the reactive gel completely restricted to the outer layer of each ascus (FIG. 1, b).

1) KÖHLER (1968:35) noted three species (e.g. *Lecidea umbonata*) with both ascus and paraphyse gel to be reactive. Reexamination of material kindly sent to me by Dr. V. WIRTH revealed a strongly euamyloid gel matrix filling all the intercellular space within the hymenium (FIG. 2, c). Yet, the rather thin paraphyse gel being covered by the black pigment proved inamyloid, and concentric zones of higher reactivity around the asci revealed the euamyloid gel to originate from the ascus surface. Similar conditions were studied e.g. in several *Lecanora*-species. In crush mounts, the reactive gel may become completely detached from both ascus wall and paraphyse gel by pressure on the cover slip, or ruptured to form lumps on both elements. This misleads to take the paraphyses to have an amyloid gel.

FIG. 1. Hymenial elements from four orders of Ascomycetes showing microstructures reactive to iodine: a) Lecanorales (*Lecidella elaeochroma*), b) Ostropales (?*Karstenia loniceræ*), c) Verrucariales (*Verrucaria* ?*floerkeana*), d) Helotiales (*Pezicula cinnamomea*), dead state. Sections of ascocarps 100x, asci and paraphyses/-oids 1000x.



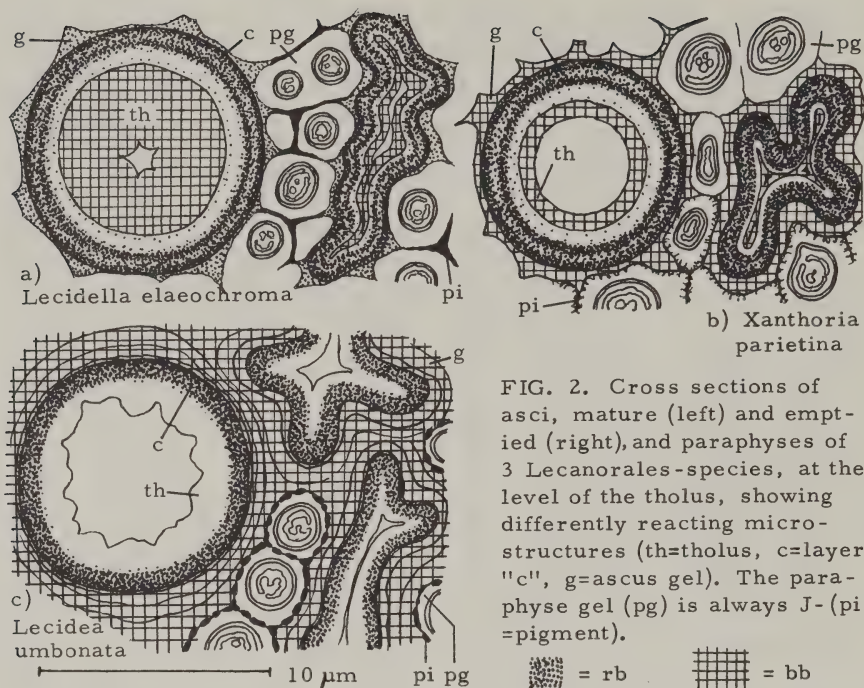


FIG. 2. Cross sections of asci, mature (left) and emptied (right), and paraphyses of 3 Lecanorales-species, at the level of the tholus, showing differently reacting microstructures (th=tholus, c=layer "c", g=ascus gel). The paraphyse gel (pg) is always J-(pi=pigment).

The lecanoralean ascus ("archaeascus") was found to show the most diversified case of iodine reactivity. Mostly, different types are present in different wall layers: The tholus (= apical thickening of layer d_2 , in BELLEMÈRE's terminology) is mostly of type bb (or (r)b; though often only faintly J+ or even J- in Melzer's reagent) (FIG. 1, a). Some species' tholi are chiefly J- in IKI (FIG. 2, c), while others form a lateral amyloid inner layer that reaches the base of the asci (e.g. *Brigantiaea*, HAFELLNER & BELLEMÈRE 1981). While layer d_1 is inamyloid, layer c was found to react "rb" in every species studied by me (FIG. 2, a-c), at least in the upper region of the ascus. Reactivity of layer c is well figured in HAFELLNER & BELLEMÈRE (1981) for *Brigantiaea*, or in HON-EGGER (1978:62) for *Xanthoria* ("ad"). Contrary to the tholus, the reactive structure is non-fibrillar and less conspicuous in TEM (HAFELLNER, pers. comm.). The gelatinous excretion produced by layer a covers the whole ascus and also the ascogen hyphae, and may either be rather thin (FIG. 2, a, b), or very thick (FIG. 2, c). This gel was always reactive, either of the same type as layer c (FIG. 2, a), or of type bb (FIG. 2, b, c) and then strongly blue in Melzer's reagent.

Some authors have paid attention to these striking differences in the type of reactivity: The remarkable tendency of having the tholus of type bb and the outer ascus wall layers of type rb was also stated e.g. by POELT & VĚZDA (1977 & 1981), OBERHOLLENZER & WIRTH (1984), and KILIAS (1981: Tab. 1) (see appendix). The differences between ascus gel (bb) and layer c (rb) were indicated by KÖHLER (1968:23 & Abb. 5),

and KILIAS (1981:255); layer c was erroneously termed "Gallerthülle" or "Schleimhülle", because it was found to become detached from ?layer d by strong pressure like a gel (KÖHLER, l. c.). These differences are less obvious in crush mounts in comparison with sections because the blue gel covers the red-brown ascus wall so that the latter is easily to be overlooked. TEM-studies indicate only the Patag⁺-reaction for both structures, and slight differences in their ultrastructure. Likewise, workers who employ very dilute IKI solutions or use the iodine test only after KOH pretreatment, observe only one type of color reaction (blue) in both structures.

Taxa with reduced tholi tend to have the gel to react bb in the apical region, rb in the lateral region (?Karstenia: FIG. 1, b, Dactylospora, Polychidium, Peltigera).

The reactive gel is produced very early in the ontogeny; it is present outside very young asci and even ascogen hyphae (FIG. 1, a-c; CHADEFAUD 1973: Fig. 5), whereas that of the apical apparatus arises about during the stage of meiosis (FIG. 1, a, b, d). No change in the (sub)type of reactivity during ontogeny was ever observed in any order.

Helotiales (and Sphaeriales) -hymenia are devoid of reactive gels or reactive lateral ascus walls (cfr. NANNFELDT 1932:62; exception: Nothomitra, Geoglossaceae, see appendix). Reactivity is restricted to the apical ring or limited regions around the ring.

A phenomenon I have discussed elsewhere (BARAL 1987 a, b) concerns most of the Helotiales- and Lecanorales-species: Apical rings or tholi are strongly compressed in living turgid asci and become watersoaked by swelling enormously when killed. Thereby, the amyloid area in optical section increases dramatically. This property of functional importance seems to be little known among workers. Likewise, the "thick" layer ?d₁ of the lecanoralean ascus wall is in the living condition a thin layer, capable of becoming watersoaked when killed. IKI permits observation of vital stains whereas Melzer's reagent immediately induces swelling of these wall regions.

Furthermore, apical thickenings use to be much more compressed in mature dead asci compared to unripe stages. Some workers (e.g. ZIEGENSPECK 1924:118, CHADEFAUD 1942:65) tried to explain this apparently decreasing reactivity by the consumption of the amyloid reacting substance, a theory that must be abandoned since the effect is nearly absent in living asci.

THE INFLUENCE OF THE IODINE CONCENTRATION

A thorough investigation on this influence on the color reaction in lichen hymenia was carried out by KÖHLER (1968). The idea to this unpublished study came from Prof. J. POELT. POELT's main intention probably was to investigate the "rb-phenomenon" and its separation from types rr and bb. Unfortunately, KÖHLER employed an IKI solution with a very high KI titre (14 - 20%); his results are therefore difficultly to compare with mine.¹

TAB. 2 gives a representative survey of my investigations on the nearly 100 species studied. The 16 species treated in it (4 rr-species, 9 rb-species, 3 bb-species) are purposely arranged in this symmetrical form in order to emphasize the impossibility of finding clear hiatuses, as well between rr - rb and rb - bb, as within type rb itself. The different values of the critical concentration c_{rb} found in the studied species (or structures) allow arrangement in this way (cfr. FIG. 3): Those structures with a low c_{rb} -value (in reactive hymenia: narrow blue zone quickly followed by a broad red zone) are placed close to type rr, those with a high c_{rb} -value (broad blue zone turning finally dirty-red) close to type bb.

Transitional species are termed "r(b)" (situated between rr and rb) and "(r)b" (situated between rb and bb) (FIG. 3). The subtypes of type rb are marked (e.g. in the appendix) by adding the c_{rb} -value to the symbol "rb" by a hyphen (e.g. Rinodina bischoffii: rb-0.12).

All observed c_{rb} -values lie within the range of 0.03 - 0.5 (-1)%. Thus, it is sufficient to work with the seven IKI reagents on the right side of TAB. 2.

Evaluation of c_{rb} requires a standard method: The reagents must be applied separately to very minute dried fragments of the hymenium. The fragments have to be crushed by pressure on the cover slip. The temperature was always 15 - 18°C. Contrary to KÖHLER, I have chosen to employ IKI with gradually ascending I_2KI concentration, and with consistently the triple KI titre (in concordance with MELZER's original formula). Though KI might even induce falsifying effects if thus applied, it is indispensable to add any ingredient in order to get the iodine concentrations required here.

Though the color change from blue to red takes place within a narrow range of iodine concentration, this method is not very exact, and the c_{rb} -values are probably provided with an average deviation of ca. $\pm 20\%$, because the reactive structures accumulate iodine from the medium (see below). Attention must be paid to the rapid decrease of the iodine titre of the IKI reagents within a few days, as mentioned above.

Lugol's solution sensu stricto (0.33% iodine, see TAB. 1) was proposed by OBERHOLLENZER & WIRTH (1984:540) as a standardized 1) KÖHLER diluted an "S₁" of 1.7% I_2 /13.6% KI with a 20% KI solution instead of using mere water. The red hemiamyloid reaction is treated by him as a yellow color (:19, termed "J-"), due to the influence of the ample KI on the iodine complex. The distinction between euamyloid (bb) and hemiamyloid (partially "J-") was nevertheless detected (:31): Type rb showed the blue reaction either by rinsing with water, or by direct application of IKI with low iodine titre (consistently below 0.025 - 0.05% I_2 , :30). The red reaction (type rr or rb) was now and then obtained for a moment when rinsing with water (:16). The KOH-induced blueing of "J-" structures is also reported (:36).

TAB. 2. Relationship between iodine concentration and color reaction in 10 Helotiales-, 2 Lecanorales-, 2 Ostropales/Gyalectales, 1 Verrucariales-, and 1 Dothideales-species. Above: non-pretreated; below: pretreated by KOH (100°C, momentarily, concentrated); left: color reaction in 11 differently concentrated solutions of IKI; right: in Melzer's reagent. Explanation of signs: r = red, b = blue, v = violet, g = grey, gn = green, - = negative, _ = strong, () = faint, [] = rare. The dotted diagonal line marks the color change from blue to red. (g) = ascus gel.

I ₂ (%)		7.2	4.5	3.1	1.8	1.0	0.56	0.32	0.18	0.1	0.056	0.032	Melzer's
I ₂ (mgm)		1000	560	320	180	100	56	32	18	10	5.6	3.2	
KI (mgm)		3000	1680	960	540	300	168	96	54	30	16.8	9.6	
H ₂ O (mgm)		-	-	-	-	-	10,000	-	-	-	-	-	
species		color reaction											
Belonium hystrix	rr	r	r	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	r	(<u>r</u>)	-	-	-
Pezicula alni	rr	r	r	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	r	(r)	-	-	-
Verrucaria ?floerk.	rr	(r)	(r)	(r)	r	<u>r</u>	<u>r</u>	<u>r</u>	r	r	<u>r</u>	-	-
Epibryon muscicola	rr	-	-	-	((r))	(r)	(r)	r	r	r	r	(<u>r</u>) ?(b)	-
Dimerella diluta (g)	rb	(r)	(r)	(r)	r	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	r	<u>r</u> b	(b)
"Cryptod." rhopal. (g)	rb	((r))	(r)	r	r	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	r	(bgn)	-	-
Calycina herbarum	rb	(g)	(rg)	(rg)	r(g)	r(g)	r(g)	r(g)	rg	rg	(<u>rg</u>) bg	(bg)	(bg)
Allophyl. subhyal.	rb	<u>rg</u>	<u>rg</u>	<u>r(g)</u>	<u>r(g)</u>	<u>r(g)</u>	<u>r(g)</u>	r(g)	r(g)	<u>r(g)</u> b(g)	b(g)	-	((g))
Rinodina bischoffii (g)	rb	r	r	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	<u>r</u>	r	b(gn)	b(gn)	(<u>b</u>) -	(<u>b</u>) -
Belonid. sulphur.	rb	(rg)	r(g)	r(g)	r(g)	r(g)	r(g)	r(g)	rg	bg	bg	(bg)	-
Chlorosc. alutipes	rb	(rg)	rg	rg	rg	rg	rg	rg	bg	bg	-	-	((g))
Ciboria bolaris	rb	(r)g	(r)g	rg	rg	rg	rg	b(g)	b(g)	b(g)	<u>b(g)</u> -	-	-
Bisporella citrina	rb	(g)	g	rg	rg	rg	rg	b	b	b	b	(bg)	(bg)
Hymenosc. scutula	bb	g	(b)g	bg	bg	bg	b(g)	b(g)	b(g)	(bg)	(bg)	(<u>bg</u>) -	(bg)
Bulgaria inquinans	bb	(g)	(bg)	bg	<u>bg</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	b	b(g)
Xanthoria parietal. (g)	bb	bg	bg	<u>bg</u>	<u>bg</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	b	<u>b</u> [v]	<u>b</u> [v]	<u>b</u>
- - - ↑ - - - - - non-pretreated - - - - - ↑ - - - - -													
- - - ↓ - - - - - KOH-pretreated - - - - - ↓ - - - - -													
Pezicula alni	rr	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	b	b	<u>bg</u>
"Cryptod." rhopal.	rb	-	((bgn))	(bgn)	<u>bg</u>	<u>bg</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	(b)	(b)	(b)
Calycina herbarum	rb	(g)	(bg)	b(g)	b(g)	b(g)	b(g)	b(g)	bg	bg	bg	(bg)	b(g)
Rinodina bischoffii	rb	(ggn)	ggn	b(gn)	b	b	<u>b</u>	<u>b</u>	<u>b</u>	b	b	(b)	b(g)
Bulgaria inquinans	bb	<u>g</u>	<u>g</u>	<u>g</u>	<u>bg</u>	<u>bg</u>	<u>bg</u>	<u>bg</u>	<u>bg</u>	<u>bg</u>	b(g)	b	<u>bg</u>

method to avoid contradictory results concerning the red and blue reactions (applied to dried material). This reagent evokes the red reaction in the major part of the rb-species if it had not decreased in concentration with age. Those workers who will content themselves with the use of a single IKI reagent should rather employ one with 1% iodine (this will probably work well for several months).

The minimum concentration required for a positive reaction (" c_{min} ") was found to lie within the range of ca. (0.005-) 0.02 - 0.1 % iodine. Usually, rr- and rb-species require a somewhat higher concentration than bb-species (TAB. 2, FIG. 3). KOH pretreatment adjusts these differences. Other reactive substances (amylose, glycogen, xylan, etc.) show its c_{min} to lie approximately within this range (see TAB. 5). Striking differences in c_{min} were indicated for the red reaction in the Collema-thallus gelatine by DUGHI (1942, according to DEGELIUS 1954: 52).

Yet, the presence of KI strongly influences c_{min} : While KÖHLER indicated Xanthoria parietina to react already at 0.0008% I_2 , this species requires 0.05% I_2 if KI is nearly absent. This decrease of the c_{min} -value was also noted by v. WISSELINGH (1898:635) for amyloid reactions in vascular plant cell walls, using 0.2% KI & 10 % H_2SO_4 .

Iodine concentrations near c_{min} produce inconsistent reactions and sometimes even reddish-violet colors in blue (bb) reacting structures (TAB. 2; OBERHOLLENZER & WIRTH 1984:540/547; KÖHLER 1968: 30). Iodine concentrations above 1% may diminish or even clear the reaction (TAB. 2). Furthermore, the reaction then becomes more inconspicuous due to yellow-brown stains of the cytoplasm etc.

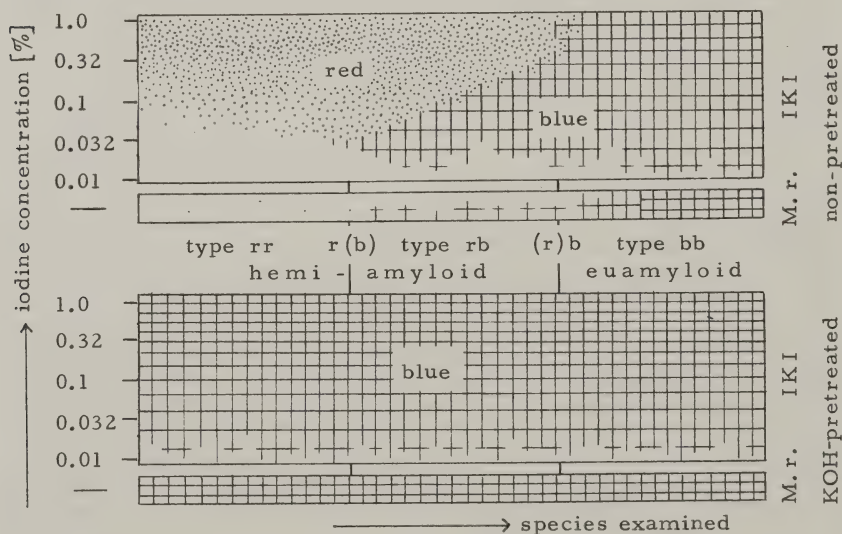


FIG. 3. The three types of amyloidity: Color reactions in IKI and in Melzer's reagent, without and with pretreatment by KOH (concentrated, at 100°C, momentarily). (Graphic representation of TAB. 2.)

With the results presented on TAB. 2, we should be aware of the fact that the observed color reactions depend rather on the iodine concentration within the reactive wall material. Though it seems impossible to determine this concentration, the following observation confirms that it is higher than that of the medium: Crush mounts of not too small-sized dried apothecia of rb-species show blue stained asci within the central region of the mount when moistened in IKI with a somewhat higher iodine concentration than c_{rb} . Whilst the exposed parts rapidly turn red, no change may happen in the central regions even after hours. Likewise, bb-species, or starch granules, may remain J- in the central region in dilute IKI though being perfectly moistened by the liquid. The effect obviously cannot be explained by a prohibited infiltration by the liquid, but only with the assumption that the reactive substance absorbs iodine from the medium (selective enrichment comparable to "metachromasy by ultrafiltration" of dyes, SINGER 1975:92). The reaction remains blue (or negative) because the available amount of liquid around each ascus is limited in the central region of the mount. Therefore, the fragments have to be as minute as possible, they must be crushed in order to eliminate iodine gradients.

Iodine reactions happen by reversible incorporation of the iodine: Every reaction, even the dextrinoid and euamyloid reactions, can be removed completely by placing the fragment into enough water, either within seconds (Pezicula), within ca. an hour (Xanthoria), or within (hours or) days as was stated by NÄGELI (1860:187) for starch. In rb-species, this method replaces the red reaction within seconds by the blue one which disappears only within minutes. These striking differences in time tell for different affinities (FÜSTING 1868) of the reactive materials to iodine. Likewise, c_{min} gives evidence of such differences. Thus, all reactive materials, especially those with low affinity (red hemiamyloid reactions), require a certain stable iodine titre in the medium in order to maintain the reaction. Iodine reactions represent a balance between iodine titre of the medium and iodine titre of the reactive material. This balance is established within seconds according to the affinity of the material: high affinity probably means high accumulation of iodine. The existence of this balance allows evaluation of c_{rb} of the medium as described above; that of the reactive material (the degree of accumulation) remains unknown.

The balance is probably strongly influenced by temperature. Though I have not made detailed studies on that, it is evident, that the c_{rb} -value increases at higher temperature: Boiling an IKI mount removes every iodine reaction for a short time, as was stated by FÜSTING (1868:661), TOBLER (1925:114), and NANNFELDT (1976:283). In rb-species (Rinodina), I have observed that the blue reappears at first on cooling down the slide. 40°C seem to clear a reaction already entirely. Thus, a temperature of 25°C might already influence the c_{rb} -value noticeably, compared with the 15 - 18°C employed here.

The KI titre does not appear to influence considerably the c_{rb} -value. Yet, detailed experiments have not been done. FÜSTING (1868) believed the presence of KI essential for rb-species with c_{rb} at the higher range to get the red reaction. However, higher iodine concentrations

can also be obtained with high temperature instead of using ingredients. Thus, it is easy to get a red reaction e.g. in *Rinodina bischoffii* ($c_{rb} = 0.12\%$) when boiling a drop of water, iodine crystals and the specimen momentarily on the slide, whereas iodine in cold water (0.03%) is just able to evoke a faint blue reaction.

CLEARING EFFECTS AND CHANGES IN COLOR REACTION INDUCED BY INGREDIENTS

Several agents have been added to iodine solutions for different purposes (see TAB. 1). All of them cause reversible suppression (partially or entirely) of red reactions (or even the blue ones in rb-species) of the hemiamyloid type and some other types (see. TAB. 5), if added in high concentration (20 - 70%). The red reaction reappears when the treated fragment is put in a drop of water. (This effect is highly demonstrative even for the unaided eye with Melzer's-treated agar powder.) Hence, the iodine molecules that produce the colored complex are not removed from the reactive substance, but rather the chemical quality of the complex is changed by the influence of the clearing agent. The red reaction reappears because rinsing with water removes the agent much more rapidly from the reactive material than the incorporated iodine.

FÜSTING (1868) observed clearing effects evoked by water, high temperature, alcohol, KOH, and compounds containing iodine (KI, HI, ZnI_2). It must be added that chloral hydrate, lactic acid, glycerin, and probably many other compounds produce comparable effects. The effects of water and temperature are discussed above. KOH transforms the I_2 molecules into non-reactive I^- ions. The iodides and the organic compounds influence the I_2 -complex but do not destroy it.

TAB. 3 shows the influence of chloral hydrate on the color reaction. It is obvious, that concentrations of 50% or even 25% clear the red reaction in types rr and rb entirely, whilst the blue in type rb may faintly be present (see also TAB. 2), and that though the iodine concentration is 1 - 2%. The quality of the color shade is not changed.

On the contrary, potassium iodide (KI) influences the shade of color: FÜSTING's (1868:660) observation is confirmed that a moderate KI concentration (ca. 1 - 5%) replaces the blue in (non-pretreated) rb-species (*Rinodina*, 0.1% iodine) by a green (blue-green) stain. Higher concentrations of KI change this into ochraceous (this is the yellow "J"-reaction reported by KÖHLER). Yet, I obtained in *Rinodina* with 25% KI and 0.5% I_2 a strong red-brown reaction. The greenish and yellowish stains are thus probably identical with those obtained with normal IKI within the narrow range of color change from blue to red.

As already stated, type bb may react violet at iodine concentrations near c_{min} . This reaction is enhanced to a strong violet-red in 25% KI with iodine below 0.1% in *Xanthoria parietina*, while *Bulgaria inquinans* FR. remains always blue (bb). Similarly, the botanist MEYER (1895: 23/24) reported a color change from blue to red for starch when increasing the KI concentration in IKI (he concluded that KI was incorporated

chloral hydrate { (%)		15.5	21.5	28.5	38	47.5	58	67	?72	
{ (gm)		2.0	3.0	4.4	6.7	10	15	22.5	(max)	
I ₂	(gm)	0.25	0.25	0.25	0.25		0.25	0.25	0.25	
KI	(gm)	0.75	0.75	0.75	0.75		0.75	0.75	0.75	
H ₂ O	(gm)	10	10	10	10	Melz.	10	10	10	
species	type	- - - - - color reaction - - - - -								
Verrucaria ?floerk.	rr	r	(r)/-	-	-	-	-	-	-	non-pretreated
Pezicula acericola	rr	(r)	(r)	(r)	(r)	((r))	-	-	-	
"Cryptod." rhopal.	rb	(r)	(r)/-	-	-	-	-	-	-	
Rinodina bischoffii	rb	r	(r)	(b)/-	(b)/-	(b)	(b)	(b)	(b)	
Calycina herbarum	rb	bg	bg	bg	(b)	(b)	((g))	((g))	((g))	
Bisporella citrina	rb	(bg)	(bg)	(bg)	(bg)	((bg))	((bg))	((bg))	-	
Bulgaria inquinans	bb	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	b	(b)	(b)	KOH-pretreat.
Xanthoria parietina	bb	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	b	b	
Pezicula acericola	rr	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	
Rinodina bischoffii	rb	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	<u>b</u>	(b)	-	-	
Calycina herbarum	rb	bg	bg	bg	bg	bg	bg	bg	(bg)	
Bisporella citrina	rb	bg	bg	bg	bg	bg	bg	bg	bg	

TAB. 3. Clearing effect of 8 different chloral hydrate concentrations of "Melzer's reagent" in 4 Helotiales-, 1 Ostropales, and 3 lichenized species. Above: non-pretreated; below: KOH-pretreated (10%, 1 min. at 18°C). Signs are explained on TAB. 2.

into the glucose polymer). Though these reactions might be of taxonomical value (KÖHLER 1968:30 observed this red-violet reaction in hymenial gels but not in tholi), I feel that a low KI titre yields more clear informations about the hemiamyloid reaction.

Dried down IKI preparations also show a changed reaction. The blue in *Rinodina* is removed completely thereby, but not the red. The blue in *Xanthoria* becomes pale dirty-red. The original color reaction reappears in full strength if water is added.

THE PRETREATMENT

2 - 5 (- 20) % aqueous KOH solutions have been applied to herbarium specimens by both mycologists and lichenologists, mainly in order to rehydrate, inflate, and clear the tissue. For this purpose, others employ NH₄OH (SINGER 1975:94) or lactophenol/lactic acid (ERB & MATHEIS 1983:25). The pretreatment is done usually on the slide in a drop of the liquid for a certain period of time. The KOH is removed prior to mounting in media as Melzer's reagent by rinsing with water.

Furthermore, 10 - 50 % KOH (or concentrated NH₄OH) is in use for evoking macrochemical reactions with e.g. lichen thalli (or apothecia).

The frequent use of KOH especially by lichenologists led to the discovery of the provoked blue iodine reaction; the first reports appear to be those of MINKS (1881:64: J- → blue, *Pezicula*) and HUE (1904: red → blue, *Lepolichen*).

Pretreatment with a strong (undilute) base or acid is an old method for inducing hydrolysis of cell wall constituents: A thereby provoked reactivity to iodine is said to give evidence of the presence of cellulose, hemicellulose, or chitin (van WISELINGH 1898:683, STRASBURGER & KOERNICKE 1913:177, CHADEFAUD 1969:181/182). Generally, such reactions are said to take a long time (they are used to be forced by exposure to e.g. 160°C). Contrary to this, the alkali-induced color change from red to blue of the hemiamyloid reacting substance is obtained by 2-3 % KOH at room temperature within seconds.

MINKS (1879/1881) emphasized the consequent pretreatment of every preparation by KOH (of a "varying concentration", max. 20 %, for 10 minutes) followed by H₂SO₄ (ca. 20 %, for ca. 3/4 - 1 hour). Each treatment was followed by rinsing carefully with water. MINKS' objective was to obtain a "much more distinctive and beautiful" iodine reaction (1879:10), and a more cleared aspect of the preparation, e.g. by dissolution of the tissue gel in Collembataceae (1879:8). Though studying both lichens and Helotiales, he obviously mentioned only one single case (1881:64) of induced reactivity, and never any case of induced color change, probably because he did not routinely examine non-pretreated specimens. (MINKS' strong pretreatment might even have induced partial hydrolysis of cell wall constituents since he often reports reddish reactions of the whole ascus wall in Helotiales-species.)

Likewise, KILIAS (1981:257/258) was used to rehydrate lichens routinely in KOH before applying iodine. He discovered the KOH-inducible blueing of red reacting structures only when he realized that NYLANDER's and ARNOLD's material that reacts red according to these authors' notes gave instead always blue reactions with his method.

The minimal strength of KOH solution required for inducing blueing (bb) in IKI in the hemiamyloid (rb or rr) reacting substance is uniformly ca. 1-2.5 % (ca. pH 14.2) if applied for 1 minute at 18°C, in all examined orders of Ascomycetes (hymenia). This minimal strength usually evokes (weak or inconsistent) blueing in Melzer's reagent as well. Yet, some taxa require a strikingly higher KOH concentration for that (TAB. 4): Dothideales (Epibryon etc.) and Ostropales ("Cryptodiscus", ?Karstenia) require ca. 5-20 % (18°C, 1 min.). This striking difference might turn out to be of taxonomical importance in future.

The provoked blueing is strongly enhanced when pretreated with KOH of higher strength as was stated by KOHN & KORF for Melzer's reagent ("exposure to 10% KOH tends to produce a much more blue-black reaction"). This is less obvious when IKI is employed (TAB. 4).

These effects tell for different qualities of chemical change induced by KOH: The color change from red to blue (observed in IKI) may happen independently from the enhancement (? change in affinity) of the blue Melzer's reaction. KOH may even cause a color change from condition rr to condition rb (TAB. 4).

It must be concluded that KOH induces conditions that never exist in non-treated specimens of the species in question, but that may occur in related species or genera. This fact suggests that the complete transfer from rr → rb → bb (IKI) → b (Melzer's) → b (Melzer's) is effect-

ated in living bb-species by enzymes, and that already during synthesis of the material (no change in iodine reaction during maturation was ever observed).

Within the bb-species, certain species show the pale non-pretreated blueing in Melzer's reagent to become enhanced to deep blue by KOH. This speciality is not obvious with IKI and was not investigated in detail by me. Lasiobelonium variegatum and Lachnum apalum and probably many more species behave this way. They must be placed close to type rb, showing only the last step of the mentioned KOH-induced transfer (FIG. 3).

Enhancement of an existing (Melzer's) reaction occurs, however, in many rb-species as well (TAB. 2; FIG. 3). It was noted e.g. by SCHUMACHER & KOHN (1985) for certain Myriosclerotinia-species, e.g. M. sulcatula. (This species, as "Sclerotinia duriaeana", reacts "blue or violet" according to REHM 1896.) I have often observed that (perhaps all?) rb-species may (non-pretreated) either be J or J- in Melzer's reagent: The Melzer's reaction is obviously very inconsistent in this group when treating the same ascocarp repeatedly.

KOHN & KORF (1975:171) noted enhancement for Iodophanus carneus (PERS. ex PERS.) KORF (Pezizales). Material from my herbarium belongs, however, to type bb showing no such enhancement.

The period of time the material is exposed to KOH highly influences the result. The data of TAB. 4 were obtained by treating for 1 minute. When treating for 10 minutes, 0.2 % KOH solution already induced blueing even in Melzer's reagent in both Pezicula and Verrucaria.

KUROKAWA (1969:689) also treated for 1 minute (with 5% KOH). DÖBBELER (pers. comm.) obtained the blue IKI reaction by treating only for some seconds. KOHN & KORF (1975:168) treated for "at least 15 minutes" (using 2% and 10% KOH) but found (Pezicula) that "instantaneous immersion" in 2% KOH induced blueing in Melzer's reagent.

KOH (%)	0.5	1.0	1.5	2.5	5.0	10.0	conc.	
<u>Pezicula cinnamomea</u>	rr --	[rb]/bb --/(b)	bb --/(b)	bb (b)	<u>bb</u> <u>b</u>	<u>bb</u> <u>b</u>	<u>bb</u> <u>b</u>	IKI Melzer's
<u>Verrucaria ?floerkeana</u>	rr --	rr --	rr --	rb/bb ((b))	bb (b)	bb b	bb b	IKI Melzer's
<u>Epibryon muscicola</u>	rr --	rr? --	(rr) --	bb --	bb ((b))	bb (b)	<u>bb</u> <u>b</u>	IKI Melzer's
" <u>Cryptodisc.</u> " <u>rhopaloides</u>	rb --	rb --	(rb) --	bb --	<u>bb</u> --	<u>bb</u> ((b))	<u>bb</u> b(gn)	IKI Melzer's

TAB. 4. Significant differences between the IKI reaction and the Melzer's reaction exemplified for 1 Helotiales-, 1 Verrucariales-, 1 Dothideales-, and 1 Ostropales-species, pretreated by 7 different KOH solutions (for 1 min. at 18°C, except "conc.": momentarily at 100°C; applied to small fragments of the specimens). Signs are explained on TAB. 2.

KOH-pretreated material was rinsed in water in order to remove excess KOH according to the instruction of KOHN & KORF (1975:168), because KOH absorbs the added iodine by forming KI. However, DÖBELER (pers. comm.) practised KOH-pretreatment by adding (amply) IKI directly to the KOH mount (at the edge of the cover glass). DÖBELER's report (1978:12) might mislead to think that the provoked blueing requires an alkaline medium to be maintained. A simultaneous application of both KOH and iodine proved impossible: This incompatibility does not allow watching the process of alkali-induced color change from red to blue. (This incompatibility led SMITH (1966:158/159) even to advise never to "revive" sections in a base if an iodine test is intended.)

Other anorganic compounds (NH_4OH , KCl , NaNO_3) failed to induce blueing in Melzer's reagent (KOHN & KORF 1975:170, NANNFELDT 1976:284) except for NaOH . I have undertaken testing with $\text{Ca}(\text{OH})_2$, K_2CO_3 , NH_4OH , and an organic base, triethanolamin. The two latter (pH ca. 12.0) did not induce blueing (in IKI) even if momentarily boiled without cover glass (*Pezicula*).¹ Both K_2CO_3 (50% aqueous, pH 13.8) and $\text{Ca}(\text{OH})_2$ (saturated, pH 13.7) evoked strong blueing in IKI if thus boiled. $\text{Ca}(\text{OH})_2$ (but not K_2CO_3) evoked strong blueing even if applied for 15 minutes at 18°C.

Acids (HCl or H_2SO_4 , 20-50%) are unable to induce blueing of hemi-amyloid structures (applied for 15 min. at 18°C). No acid treatment between alkali and iodine (MINKS' method) is required as was believed by O. & B. ERIKSSON and KUOKAWA.

Boiling momentarily in mere tap water is inefficient. Surprisingly, boiling in tap water for 10 - 15 minutes induced blueing in IKI in *Pezicula* (boiling for 5 minutes is inefficient). Thus, not even an alkaline treatment is necessary for this chemical change.

A strong KOH treatment (10%) may disrupt the apical ring (KOHN & KORF 1975:FIG. 6). The reactive substance thereby shows the appearance of being melted by forming "trailing portions" into the ascus lumen. A similar effect was obtained with the dextrinoid reacting spore wall material in *Pseudographis*.

A strong acid treatment (HCl 20-25%) dissolved a small part of the reactive substance in *Xanthoria parietina* by forming a blue halo in a medium containing HCl and IKI. The same medium evoked a (reversible!) grey-blue reaction in non-pretreated *Pezicula*-asci.

The alkali-induced blue iodine reaction (change from red to blue) obviously must be considered an irreversible chemical change: No treatment was found to reestablish the rr- or rb-condition. Contrary to this, color reactions that are directly caused by alkali or NH_4OH without presence of iodine "can often be reverted at a given pH by application of diluted acid" (SINGER 1975:106).

1) Yet, exposure to NH_4OH for 6 hours at 18°C (in a phial) induced blueing in IKI in *Pezicula cinnamomea* (Melzer's reaction: faintly blueish; exposure for 2 days induced strong blueing in both reagents), while exposure for 2 hours was inefficient.

HEMIAMYLOIDITY OF EXCIPULA AND ASCOSPORES

The entire ectal excipula of both Perrotia flammea and Proliferodiscus pulveraceus display a deep wine- or purplish-red reaction in IKI (von HÖHNEL 1917, according to DENNIS 1949:58, as "blood-red", for the latter species). DENNIS did not obtain the reaction by himself because he used Melzer's reagent. A strong KOH pretreatment produces a blue(-grey) or blue-violet reaction even in Melzer's reagent. Whilst the blue-violet reaction in Proliferodiscus is obtained merely by applying KOH without presence of iodine (see DENNIS, l.c.), that in Perrotia is undoubtedly a KOH-induced change in iodine reactivity (KOH itself produces no reaction in the excipulum but dissolves merely the purplish pigment in the hair granules). In both species, these reactions take place in the intercellular gel (cell walls and plasma remain unstained). The blue-violet reaction in Proliferodiscus is obtained in the same quality in NH_4OH as in 2-10% or even boiled concentrated KOH. But only the latter treatment evokes the blue(-violet) IKI reaction that becomes evident if the pretreatment was followed by a strong H_2SO_4 treatment in order to remove the violet KOH color reaction. Likewise, Perrotia requires strong KOH pretreatment.

DÖBBELER (1981:458/459) reported for "Hymenoscyphus" erythropus DÖBB. a red reaction of the cell walls in the basal parts of the stipe in IKI, turning (lilac- or dirty-) blue by KOH pretreatment. Furthermore, several Dothideales-species are said to show such a reaction of sterile parts of their ascocarps (cell wall or gel; see appendix).

A submers growing Ascomycete, Obtectodiscus aquaticus, a taxon of doubtful taxonomic relationship, kindly sent to me by Prof. E. MÜLLER, shows quite the same reaction as reported for Perrotia, but the reactive substance is located in the aura-like surface and the appendages of its needle-shaped ascospores. The reaction is deep wine-red in IKI ("iodo rufescentes", MÜLLER et al. 1979), but disappears when pretreated by KOH since KOH dissolves the substance. Yet, the epiplasma of asci with mature spores shows a (KOH-induced) dark violet-grey reaction in both IKI and Melzer's reagent.

Another aquatic species, Loramyces macrospora, behaves likewise: The gelatinous coat of its sperm-like ascospores was found to react deep red in IKI by the collector, C. SCHEUER (this feature might be unknown so far since the Melzer's reaction is negative). A strong KOH pretreatment was necessary to induce an(intense!) blueing in IKI of the gel around the spores inside the asci while epiplasmatic regions of ?glycogen remained red, and discharged spores lost reactivity.

RED IKI REACTIONS BEING J- IN MELZER'S REAGENT BUT NOT BLUE BY KOH PRETREATMENT

Agar, a polysaccharid obtained from the cell walls of Rhodophyta, shows a deep wine-red stain in IKI (rr). KOH pretreatment does not change this reaction (even if momentarily boiled). ROSENTHALER (1928) found a reversible change to blue-violet when having the agar boiled in pure water for five minutes (cooled down). Rinsing an 18°C -

Melzer's mount brings back the red reaction that changes thereby to first deep violet then pure blue (TAB. 5). The blue reaction is obviously caused by a lower iodine concentration but is not obtained if IKI with low concentration is directly applied. There are further gel substances obtained from Rhodophyta with a red-violet reaction (ROSENTHALER).

The frequently reported wine-red reaction of the Collema-thallus gel is said to vary strikingly in its $c_{\min}$ (IKI) among species from 0.25 to 10 % (!) iodine; reactivity is referred to glycogen (see DEGELIUS 1954: 52). I found (fresh) Collema limosum to react deep wine-/salmon-red in IKI with 0.56 % iodine while 0.32 % gave no reaction at all. Collema furfuraceum (ARNOLD) DURIETZ em. DEGEL. (GZU), was not even distinctly red with 1.8 % iodine.

The Melzer's reaction was negative, even if the species were pre-treated with IKI (1.8% iodine). Rinsing in water rapidly removed the IKI reaction without color change; no red reappears with a Melzer's mount. KOH pretreatment (conc., 100°C) does not change anything except that the gel becomes liberated from the thallus texture. The negative Melzer's reaction and the strikingly high $c_{\min}$ -value tell for another substance than glycogen.

The cytoplasm of both paraphyse apices and cortical excipular cells reacts reddish in several Helotiales-species by forming small guttule-like bodies. These may also appear in the medium in some species (e.g. Hymenoscyphus immutabilis (FUCK.) DENNIS) by forming a reddish halo around the fragment. This causes intransparence and contamination-like appearance of the preparation, especially with higher concentrated IKI. The reaction is obtained in fresh as in 12-years-old material. A strong pretreatment with KOH destroys the reactive substance, a weak pretreatment evokes no changed behaviour (J- in Melzer's reagent). The effect obviously originates in an oleaginous cytoplasmatic content of low refractiveness.

Pezizula-hymenia usually show a similar reddish halo of minute granules originating from the paraphyses (and cortical cells). There are, however, crystalline extracellular exsudations that become deep purple when chloral hydrate is added (see below).

THE DEXTRINOID REACTION

The term "dextrinoid" was introduced by ORTON (1960:locus?) (according to A. SMITH 1966:159 and SINGER 1975:98) for a ?red-brown reaction of Basidiomycete cell walls of spores or hyphae in probably Melzer's reagent.

The term "pseudoamyloid" is an approximate equivalent, according to SMITH (l. c., as "pseudamyloid"), and was introduced by SINGER (1938:191) for a brown to purplish-brown reaction of the basidiospore wall in Lepiota and Baeospora in Melzer's reagent with $\pm$ the original formula. SINGER (1975:98) therefore claimed his term to have priority for 22 years. My studies revealed differences in behaviour within the "dextrinoid reaction", yet the present knowledge is not sufficient for deciding whether these terms are synonymous. I have used ORTON's

term here merely because I met with it more often in the literature.

Concerning the delimitation from (eu)amyloidity, SINGER (1975:97) stated that "they are clearly different in color in the spores of Basidiomycetes, yet they sometimes intergrade almost unnoticeably in the hyphal walls".

The following examples have in common the red or violet reaction being obtainable in Melzer's reagent with the same depth and shade as in IKI, and being not changed to blue by KOH pretreatment. DÖBBELER (1981:404/405/422) likewise distinguished red reactions being not changed to blue by KOH (content of excipular cells in Bryorella compressa DÖBB., walls and intercellular gel of subhymenial hyphae in Dawsonia neglecta DÖBB.), but restricted the term "dextrinoid" to stains of the cytoplasm (i.e. the former case).

A special type of reaction (Mycena-trama, Pezicula-crystals) is characterized by a deep Melzer's reaction whilst the IKI reaction is nearly J- (see below). It must be noted that I have never observed a dextrinoid reaction in ascus wall layers or hymenial gels.

1) No blue reaction by any treatment:

The surface of the basidiospore wall of Macrolepiota procera (SCOP.:FR.) SING. and Lepiota ? clypeolaria (BULL.:FR.) KUMMER shows a strong copper-pink to fox- or wine-red reaction in both IKI and Melzer's reagent ("pseudoamyloid", generic character of Lepiota, SINGER l. c.). Rinsing with water does not change color (copper- to purplish-pink). Even strong KOH pretreatment does not change this (but diminished reactivity occurred). Rinsing with chloral hydrate solution gives best results.

Basidiospores may lose "dextrinoidity" within weeks (!) in the herbarium (CLEMENÇON 1971, Rozites caperata (PERS.:FR.) KARST.). The above material was 1/2 year old. SINGER (1975:95) indicates "pseudoamyloidity" of spore walls to become gradually lost only in material older than 100 years, that of hyphae and amyloidity not even in PERSOON's herbarium.

Basidiospore markings (exospor) in Russulaceae react rather violet, not black as stated by KOHN & KORF (1975) (cfr. SINGER 1975:97). KOH or NaOH dissolves the reactive substance (TAB. 5) as indicated by JOSSERAND (1940). LOQUIN (SINGER 1975:97) therefore thought it to be amyloids and termed this iodine reaction "amylaceous". DODD & McCracken (1972) proved it to be amylose (see below).

SVRČEK (e.g. 1984) reported "(strongly) dextrinoid (wine-red)" reactions in Melzer's reagent of e.g. excipular cells in certain Helotiales-species. I noticed a red-brown (-purplish) reaction of cell walls of all sterile parts of the apothecium (especially the ectal excipulum) of Ungicula eurotioides (KARST.) NANNF. in Melzer's reagent (IKI reaction was not so significant). KOH did not evoke any change.

Mycena galericulata (SCOP.:FR.) GRAY shows the trama (lamellae) to react purplish-pink to wine-red in Melzer's reagent ("pseudoamyloid", generic character of Mycena, SINGER 1975:97). Rinsing with water rapidly removes this color (no change of its shade was observed).

IKI may evoke an inconsistent reaction at the edge of the section, or no reaction at all (!, with any iodine concentration). Yet, adding chloral hydrate solution effectuates the reaction intensely even if all excess iodine was removed with water beforehand. A strong KOH pretreatment gives positive IKI reactions without presence of chloral hydrate (TAB. 5). The method of adding the clearing agent to the IKI mount produces much more intense red reactions than using Melzer's reagent directly. Lactic acid is of similar, glycerin of no efficiency.

The genus Pezicula (all examined species except P. acericola and P. myrtilina) shows crystalline deposits on the paraphyse and excipular surface (and even the asci) reacting deep (blackish-) purple in Melzer's reagent. The reaction is not diminished when repeatedly rinsed with water. The crystals are inconspicuous in IKI (only few of them may sometimes react purplish). KOH pretreatment evokes no changed behaviour. The differences in appearance between Melzer's and IKI mounts are highly striking since the red IKI reaction of both apical rings and paraphyse plasma is absent in Melzer's reagent. The crystals vary strongly in size and shape sometimes being branched like ice crystals (FIG. 1, d).

The ubiquitary occurring homogen red-brown or "amber" reaction of the epiplasma in unripe asci (Nr. (8) in KOHN & KORF 1975:166) usually taken to be glycogen, is obtained in both reagents and not changed by KOH. Yet, especially strong KOH pretreatment detracts the reaction (?by dissolution); this was also noted by KOHN & KORF (1975:171).

OBERHOLLENZER & WIRTH (1984:549) reported for the genus Fusidea a red reaction of the ascus plasma in Lugol's solution which could be repeatedly be removed by rinsing with water.

2) Rinsing with water evokes a blue reaction:

The glassy substance in the hairs of Unguicularia unguiculata v. HÖHN. (especially the below region of each hair, not its primary wall) displays a red-brown color ("dextrinoid", RASCHLE 1977) in both reagents. KOH pretreatment may considerably enhance the reaction (becoming black-red). Rinsing with water evokes a blue reaction in many hairs (KOH pretreated or not), or completely removes the iodine. The blue reaction is undoubtedly caused by diminishing the iodine concentration in the hair, but is much less obvious (violet) if directly mounted in low-concentrated IKI (TAB. 5). Exactly the same behaviour (but less conspicuous) was found with the hairs of Olla (Unguicularia) scrupulosa (KARST.) SVRČEK though the latter is probably not closely related to the former species.

The exterior of the ascospore wall of Pseudographis elatina (ACH.) NYL. in KARST. reacts intensely dirty-violet or even reddish in both reagents (DENNIS 1978:162, as "deep red-brown"). Rinsing with water partially effects a blueish color (but not by mounting directly in low-concentrated IKI solution). KOH pretreatment does not evoke any change.

THE GREEN REACTION OF CAROTENOIDS

The "green" color reaction of the orange pigments (carotenoids) in the paraphyse plasma of many Pyronemataceae and Sarcoscyphaceae (BOUDIER 1905-1910, MOSER 1963:83, MEIXNER 1975) can equally be obtained in both IKI and Melzer's reagent. This is the only iodine reaction examined by me that fails to appear with herbarium specimens. KOH pretreatment does not affect the result. However, the color reaction, with or without pretreatment, may depend on the iodine concentration (*Scutellinia spec.*): If IKI (0.32 % iodine) is applied to the water mount, the color changes from distinct greyish-violet (!) to grey-olive or even grey-brown. A test with different iodine concentrations revealed the violet color to arise at ca. 0.05-0.1% iodine, the olive color at ca. 0.1-0.2%. Rinsing with water was not tested.

Sarcoscypha austriaca (BECK ex SACC.) BOUD. as well as *Orbilbia coccinella* (SOMM.) KARST. and *O. comma* GRADDON behaved likewise, yet reacted merely blue-green-olive at any iodine concentration.

MISLEADING OF THE TERMS "AMYLOID" AND "DEXTRINOID"?

Recently, these terms were considered misleading (fungi: KOHN & KORF 1975:166; vascular plants: STUMPF & CONN 1980:493), because of the implied structural relationship of the reactive substances to amylose or dextrin. However, NANNFELDT's opinion (1976:285) was that the ending "-oid" sufficiently accentuates the mere similarity to the iodine reaction of starch if applied exclusively to the word "reaction", and KORF (in litt. 19. 2. 86) has affirmed the continued use of these terms. Furthermore, a structural similarity for amyloidity of the ascus wall to amylose appears quite probable (see below). In this paper, I have applied the terms also to the reactive organelles (e. g. "amyloid ring") but never to words like "substance".

Starch granules (containing both amylose and amylopectin) produce a $\pm$ violet reaction in IKI as in Melzer's reagent. KOH pretreatment does not evoke any change (TAB. 5). The terms amyloid or dextrinoid refer to the similar shade of color reaction obtained in dilute solutions of amylose (pure blue) or dextrin (pure red) (cfr. MEYER 1895:29, BAILLEY & WHELAN 1961). I have not tested pure dextrin for whether its Melzer's reaction is also red. Certainly, application of the term dextrinoid to apical rings, e. g. by NANNFELDT (1976:285), or by me (1984) must be avoided in future.

STAINING AGENTS OTHER THAN IODINE:
THE "CHITINOID" APICAL RING

Ring- or cylinder-shaped structures in the apical apparatus of asci with active spore discharge exist in two very different reacting types (CHADEFAUD 1960:484, PARGUEY-LEDUC 1977:324): 1. the "amyloid ring" of the Helotiales, Sphaeriales, and Lecanorales; 2. the "chitinoid ring" of the Nectriales, Sordariales, and Diaporthales. The chitinoid ring is characterized by the absence of any iodine reaction (IKI).

The amyloid ring may be stained with other reagents too: Chlorazol black gives a grey color to exactly the eu- or hemiamyloid reacting region. Inamyloid Helotiales-asci do not at all show any ring structure with that agent. Congo red and (very distinctively) cotton blue in lactic acid evoke the same result (amyloid rings are cyanophile). CHADE-FAUD (1969:188) obtained some positive results (referred by him to "hemicellulose") using "orseilline BB en solution acétique" or "benzopurpurine en solution alcaline". Some other staining techniques are mentioned in BECKETT (1981:15). The polysaccharid-specific "THIERRY-test" (Patag reaction) used in TEM yields an electron-opaque (Patag+) stain to exactly the amyloid reacting region (HAFELLNER, pers. comm., GRIFFITHS 1973:267/268).

The chitinoid ring may be stained by the following agents (CHADE-FAUD 1960): Carter's midnight blue ink (or fountain pen ink), Congo red, Janus green, and Chlorazol black. This type of ring is Patag - (rarely Patag+, though being inamyloid) (BECKETT 1981:15).

THE CHEMISTRY OF IODINE - POSITIVE SUBSTANCES

Iodine reactions are commonly referred to incorporation of the iodine molecules into the core of a helical (α -glucosidic) polysaccharid by forming a colored complex (BONNER 1950). Although microchemical studies of fungal or vascular plant cell walls do not indicate occurrence of helical macromolecules (cfr. ROSENBERGER 1976:335, STUMPF & CONN 1980), glucans with α -linkage that blue in iodine were demonstrated in certain lichens (isolichenin, CULBERSON 1969:85/86) and Basidiomycetes (amylose, DODD & McCracken 1972).

1) Storage carbohydrates

According to BONNER (1950:55/56) and BAILEY & WHELAN (1961), color reactions of starch and its derivatives depend on the length of the α -1,4-glucose helix: Short helices (12-ca. 28 glucose units) form red complexes (490-533 m μ), longer helices purplish, or (45-568 units) blue ones (568-645 m μ). When amylose (long, unbranched helix) is hydrolyzed the blue color gradually changes to red (dextrin, short helix). The reddish stains of branched molecules (amylopectin: purplish; glycogen: red-brown) rest on the breaks in the helices. Both cited references provide detailed information on the chemistry of the starch-iodine complex.

2) Amylose in cell walls of Basidiomycetes

DODD & McCracken (1972) have shown that amyloidity of spore and trama cell walls (Russula, Hericium, Lentinellus, Clavicornia) rests on amylose chains (method: extract incubated with β -amylase (specific to α -1,4); complete degradation to maltose proved by chromatography) of very short length (ca. 32-58 units per chain; method: iodine spectrum according to BAILEY & WHELAN 1961). The authors suggested amyloidity of spores to function as an oxygen barrier to suppress metabolism during periods of dry weather. BLACKWELL et al. (1985) detected amylose in "additional Basidiomycete species and in an Ascomycete".

3) Dextrinoidity

BLACKWELL et al. (1985) stated that (Basidiomycete) species with a dextrinoid (red) reaction "did appear to have high concentrations of certain quaternary ammonium compounds (QACs) which are known to form a red periodide complex with KI_3 " (IKI).

4) Xyloglucans, and the "substance amyloid"

Non-helical glucose chains may also be able to form blue iodine complexes: Blueing in cell walls of vascular plants is referred to substances called "xylo(galacto)glucans" (FREY-WYSSELING 1959:145, STUMPF & CONN 1980:493). These consist of β -1,4 glucose chains having attached various short chains composed of xylose, galactose etc. In the first decades of this century, the term "amyloid" (as a substantive) was in use for them, having been introduced by WINTERSTEIN 1892 (according to FREY-WYSSELING l.c.) for blue reacting wall thickenings in seeds of Tropaeolum etc.

Blueing in iodine occurs in various parts of the cormus (cell wall) but is only present at certain intermediate stages of development ("Amyloidzustände"), being quite sensitive to chemical treatment and soluble in water or dilute acids (ZIEGENSPECK 1919:274; 1925). It was found to occur also in combination with ejaculation mechanisms (fruits of Impatiens, "Amyloidmechanismen", ZIEGENSPECK 1925: 339). Rarely, red-violet reactions were observed (l.c. :310).

However, the term "amyloid" has also been applied to "hydrocellulose" obtained from cellulose (or hemicellulose) by acid or alkali hydrolysis, e.g. by STRASBURGER & KOERNICKE (1913:177). Therefore, ZIEGENSPECK (1919:275) distinguished between "natural and artificial (chemically provoked) amyloids".

HOFFMANN (1860:313) already termed the substance of the apical ring (Bulgaria) or that of the operculate ascus "Amyloid" = "formlose Stärke" (= non-granular starch).

5) Isolichenin

Lichenologists (e.g. HENSSEN & JAHNS 1974:81/154) use to refer every blue iodine reaction of lichens to a substance isolated for the first time from the vegetative thallus of Cetraria islandica by MULDER (1838) and BERG (1873), called "isolichenin" by BEILSTEIN (1881)(cfr. TOBLER 1925:113, A. L. SMITH 1921:210). Originally a mixture of different compounds, the only reactive constituent was found to be an unbranched ?helical D-glucose chain with a $\pm$ alternating α -1,3/1,4-glucosidic linkage pattern (cfr. CULBERSON l.c.).

TOBLER (1925:115) indicated differences in solubility between isolichenin from the thallus (completely soluble in hot water) and "amyloid" from the hymenium (difficultly soluble in 50% HCl only). ZIEGENSPECK (1924) extracted "isolichenin" from e.g. Xanthoria parietina with hot water, and hydrolyzed it by 4% H_2SO_4 treatment obtaining a change in iodine reaction from blue to red within ca. 20 minutes.

I found in Cetraria islandica a distinct lilac reaction especially in the lower thallus cortex (inner layer of the highly gelatinized mycobiont

cell wall), and a rather indistinct blue-grey reaction of granular deposits on the hyphal walls of the thallus medulla. Both reactions are best visible in IKI at lower iodine concentrations (0.1-0.3%), but are not changed at 1% iodine in color. The Melzer's reaction is positive for both structures. Boiling for 1/4 hour in water did not considerably remove these substances from the cell walls. KOH pretreatment (100°C, momentarily, conc.) evoked liberation from the thallus texture but caused no change in color reaction.

6) The reactive substances of ascogen origin

The detection of isolichenin in species as Xanthoria parietina (CULBERSON 1969:l.c.) indicates presence of this substance in the hymenium or subhymenium, most probably at least in the ascus gel of this species (no extrahymenial blueing region was found by me). This probably allows the conclusion that isolichenin is wide-spread among lichens and the origin of the blue (euamyloid) reaction of the ascus gel. The universal occurrence of the hemiamyloid reaction with quite uniform properties in apical rings, the layer c, and the ascus gel, and the fact that KOH transforms it into a blue reaction indistinguishable microchemically from euamyloidity, should allow the conclusion that isolichenin with probably slight variations is also the origin of the blue reaction of Helotiales- and Sphaeriales-apical rings. Unintelligibly, workers on non-lichenized fungi ignore the knowledge about the isolichenin: This substance is not mentioned in the treatises on ascus structure and function in REYNOLDS' "Ascomycete systematics"; TEM (Thiery) gives only an unspecific test for polysaccharids.

The red hemiamyloid reaction was referred by LAMB (1947) to glycogen (KILIAS 1981:258). Likewise, KILIAS thought this reaction of lichen ascus gels to rest on branching of an unknown helical polysaccharid. Yet, a momentary treatment with 2% KOH certainly does not cut the branches in such a molecule.

The red reacting water-soluble mucilage of Red Algae (the agar) consists of galactose polymers (LEWIN 1962:339). Commercial agar was found by me to behave quite similar as does the hemiamyloid reaction (see above) except that no KOH-induced blueing was obtained.

BRODO (1973:262) believed the red reaction in Coccotrema-ascus gels to indicate absence of isolichenin, yet he did not know of the KOH-provoked blueing verified in that genus by HONEGGER (1982:215). Neither did FÜSTING (1868:662) when suggesting the existence of two "isomere" compounds in the walls of all iodine stainable lichen asci, their varying mixing proportion being responsible for all modifications of color reaction in the various species. This conception tries to explain the "rb-phenomenon" and implies the red and blue reactions to happen in separate loci or molecules within the reactive microstructure, the resulting color reaction to rest on a superposition of both reactions. The blue component should then be isolichenin.

If this conception would prove right, KOH treatment would transfer the red reacting constituent into isolichenin. Yet, there is no clear evidence that the rb-phenomenon rests on two independent loci.

The KOH-inducible blueing can probably only be referred to a mere change of the secondary structure of the reactive molecule. Investigations that intend detection of the chemistry of the rr- and rb-condition should mind that (1) the involved molecule is probably of the same primary structure as its KOH-provoked bb-condition, and (2) boiling for 10-15 minutes in water already evokes transformation into "bb" (this is the common practice for extracting isolichenin). Extraction in strong acids seems to leave these conditions rather unaffected but tends to hydrolyze the molecule.

A THEORY ON THE CHEMISTRY AND FUNCTION OF AMYLOIDITY OF ASCOGEN ORIGIN

The fact that it is only a small limited region of the Helotiales-ascus wall, the apical ring, that gives the blue (or red) iodine reaction, and that this region lines the pore through which the spores are pushed out, has long caught my interest.

In the course of my study on Helotiales-apical rings, I repeatedly found that living (turgescient) ascospores are not noticeably compressed when having got stuck in the apical porus (BARAL 1987a:Fig. 7), contrary to BECKETT's (1981:23) report that is based on dead spores. Thus, the apical ring is highly elastic.

The apical ring is everted prior to spore discharge, but not noticeably destroyed. I have therefore evaluated the degree of extension by comparing the spore width with the width of the pore (of both the everted state and the non-everted state): The diameter (or circumference) of the ring is increased during discharge for the factor 10 in *Pezizula* (or for the factor 5 - 20 in other Helotiales), and returns to its original value when discharge is finished.

Such extreme elasticity must chemically rest on polymers which energetically prefer a helical secondary structure and allow extension to a $\pm$ straight conformation. In animal organisms, such a molecule is the "elastin", a polypeptide with an α -helical secondary structure, being embedded in a ground substance, and responsible for elasticity of ligaments (LEHNINGER 1982:151 ff.; similar extensible polypeptides that form an α -helix are keratin and myosin). Extensibility of these molecules rests on free rotation around single bonds between the units, elasticity of elastin originates from intrachain hydrogen bonds.

Since blue iodine reactions usually rest on α -helical polysaccharids and blueing of apical rings probably on the α -helical isolichenin, and since this reactivity occurs just in that region where maximal extension happens during spore discharge, it appears very probable that the isolichenin is the molecule that provides the apical ring with the required elastic property. Amyloidity thus indicates elasticity in this case.

The α -helix must favourably be embedded in the ground substance, in that concentric bundles of isolichenin constitute the (hollow-) cylinder-shaped ring. The bundles form piled-up disks that become separated from each other by water intake when the ascus turgor is released (visible as Patag+ fibrils in TEM longitudinal sections, or in the LM as breaks in amyloidity). Elastic α -helices cannot be arranged vertically

within the ring because the ring spontaneously elongates by water intake when the pressure is released.

I have not investigated states of completely stretched apical rings for their amyloidity that should have decreased thereby due to elongation of the helical molecules.

A further theory concerns hemiamyloidity: The red reaction of ascus structures might originate in short helical segments (like the red reaction of dextrans) within an otherwise straight "isolichenin" molecule. A soft KOH-pretreatment (or boiling water) evokes curling of the straight segments by forming the "bb-condition". Two observations support this idea: (1) Hemiamyloid apical rings appear noticeably contracted when KOH-pretreated,¹ and (2) lecanoralean or ostropalean asci with two differently reacting microstructures mostly show the apical one that functions as the "sphincter" during spore discharge to react "bb" while the (lateral) outer layer of the ascus wall reacts "rb": The lateral wall needs a lower extensibility and is therefore provided with glucose chains that are less curled.

This theory would also explain why the red IKI reaction, especially of apical rings, is much less intense than the provoked blueing. However, it does not explain why there appear never to exist entirely straight isolichenin molecules that become curled and J+blue when KOH-pretreated. Nor does this theory explain the "rb-phenomenon". Furthermore, hemiamyloid apical rings do not appear to become less stretched during discharge.

Reactive hymenial gels might also provide the needed counter-pressure against the ascus turgor as does the layer c, especially if the gel is attached to the ascus wall by forming the coherent mass mentioned for Dothideales etc.

Sphincter mechanisms occur also in entirely inamyloid asci, e.g. the chitinoid ring of the Sordariales, or the apical mechanism of the Dothideales-ascus. Here, elasticity is also required but must rest on other substances.

Though the function of hemiamyloidity remains uncertain, its ecological advantage should be considered important on account of its frequent occurrence.

CONCLUSIONS

1) Method

Most mycologists use Melzer's reagent, most lichenologists use Lugol's solution / IKI. Some workers advise not to pretreat with a base (A. SMITH 1966:158) whereas others (e.g. HAWKSWORTH 1983:3) urge to use Lugol's iodine only after pretreatment with KOH.

Therefore, it is urgent to propose a standard method for the iodine test. This method should allow a clear diagnosis of hemiamyloidity

1) *Pezizula cinnamomea*: Size of unripe apical rings (basal width/height): non-pretreated: 3.2-3.8/3.5-4.5 μm , strongly KOH-pretreated: 2-3/3-4.5 μm . The "channel's" width decreased thereby from ca. 0.6 μm to ca. 0.2 μm . (All from dead material)

and its types since these features are found to be of high taxonomical interest.

The most important claim is to use IKI along with Melzer's reagent in all Ascomycete orders, and to employ iodine tests directly without pretreatment along with iodine tests after pretreatment with KOH or NaOH. Thereby, workers should exactly specify the employed treatment and circumstances.

The following survey on the various treatments employed in this study might cause discouragement among workers. Yet, only part of them are considered essential for delimiting the preliminary categories summarized on TAB. 5. A routine test that intends determination of the category should involve the following steps:

(1, b) → (3, b) → (3, c) → (4, b)

- (1) Influence of iodine concentration on the color reaction (use IKI with the triple KI concentration)
 - (a) Dried minute fragments are mounted directly in IKI by using a set of IKI reagents with iodine between 0.01 and 1 %
 - (b) The fragment is mounted in water; IKI (1 % iodine) is then applied to the edge of the cover glass
 - (c) The IKI mount of step (b) is rinsed with water (a drop is applied to the edge of the cover glass)
- (2) Influence of KI concentration on the color reaction in IKI
- (3) Influence of chloral hydrate (?or alternatively lactic acid)
 - (a) The dried fragment is mounted in Melzer's reagent (orig. formula)
 - (b) Aqueous chloral hydrate solution (50%) is applied to an IKI mount
 - (c) The Melzer's mount (a) or (b) is rinsed with water
- (4) Influence of pretreatment on the color reaction
 - (a) The fragment is exposed to KOH for 1 minute at room temperature by using solutions of different strength, then washed with water and mounted separately in IKI and Melzer's reagent
 - (b) The fragment is momentarily boiled in a drop of 5 % KOH on the slide over a flame, then treated as above
 - (c) Other pretreatments are tested

Since I have never observed apical rings, ascus wall layers or hymenial gels to react other than hemiamyloid or euamyloid, step (1, b) of this survey is usually sufficient for diagnosing hemiamyloidity for those microstructures, and allows even distinction between the types "rr" and "rb". It must be emphasized that hemiamyloidity is defined in this paper by the presence of a reddish reaction in IKI with 1 % iodine (see FIG. 3). All types other than hemiamyloidity are treated only tentatively here. The following list treats the special use of the different steps of the above survey:

- Step (1, a) serves for the evaluation of c_{rb} (critical iodine titre that marks the change from blue to red) and of c_{min} (required minimal iodine titre)(guidance for preparing the set of IKI solutions: see chapter "Iodine reagents").

- Step (1, b) is a routine method instead of step (1, a) and allows to observe the "rb-phenomenon" (first blue then red).
- Step (1, c) may sometimes (e.g. Unguicularia-hair) change a red stain into blue though step (1, a) yields red stains only. Furthermore, rinsing amply allows to evaluate the affinity of the reactive substance judged from the required time for removing the reaction.
- Step (2) was not studied in detail. Color changes effected by high KI titres (green, yellow, violet-red) might turn out to indicate chemical differences. Furthermore, observations suggest that the strong decrease of c_{min} in type bb effected by a higher KI titre is $\pm$ absent in types rr and rb.
- Step (3, a) serves as an exact test for the degree of suppression of a red (or blue) reaction.
- Step (3, b) is a routine method instead of step (3, a), but a suitable test for the peculiar type (e.g. Mycena-trama) that requires chloral hydrate for a clear reaction.
- Step (3, c) indicates that the iodine is still in the reactive substance: The suppressed red reactions usually reappear thereby (but are removed if too much water is applied).
- Step (4, a) serves for evaluating the minimum strength especially for inducing a blue Melzer's reaction: A high strength was found characteristic for certain Ostropales- and Dothideales-taxa (TAB. 4). Furthermore, it serves for detecting enhancement of an existing IKI (Unguicularia-hair, red) or Melzer's (certain Helotiales-apical rings, blue) reaction. Furthermore, it is a test for solubility of the reactive substance (e.g. isolichenin), and for detractation (e.g. glycogen) or disappearance of the reactivity (e.g. Russula-spore markings).
- Step (4, b) is a routine method instead of step (4, a) for ascertaining hemiamyloidity (Loramyces-spores turned only blue in IKI with this method).
- Step (4, c) comprises the use of other alkali than KOH/NaOH, and experiments of long time exposure, e.g. to NH_4OH or boiling water.

Solubility or disappearance as mentioned under step (4, a) were judged by SINGER (1975:99, emphasized by LOQUIN 1943, ?journal) to have some influence on a future subdivision of the amyloid reaction.

2) Consistency and taxonomic value of iodine reactions

A lot of comments on the reliableness of iodine reactions have been published. On the whole, literature reports emphasize the extraordinary constancy of the feature, as I have mentioned in the introduction. But variations within a species (HEIN 1976:16) or even within a single apothecium (DENNIS 1978:xxii) have been indicated. NANNFELDT who had considered iodine reactions to be of subordinate value in his early studies (1932:28), later reviewed his opinion and independently discovered the "provoked blueing" concluding (1976:286): "The ignorance of the effect of KOH (and NaOH) is certainly responsible for numerous (perhaps most) conflicting records".¹

1) One such conflict might be Velutarina rufo-olivacea and V. juniperi (DENNIS) K. & L. HOLM. The latter "species" differs, according to HOLM (1977:10), only by an ascus apex being J-. Yet, the authors might not have practised KOH pretreatment: Material

Condition and age of the material may sometimes influence the reaction: Loss of dextrinoidity of spores was indicated by CLEMENÇON (1971, Rozites, within weeks) and SINGER (1975:95, ?Lepiota, within centuries). KILIAS (1981:256, 410) indicated loss of hemiamyloidity in certain Catillaria-species within a century (having changed to type bb). I have found carotenoids to loose rapidly reactivity in the herbarium. Likewise, KOHN & KORF (1975:170) indicated differences between fresh and dried material (blueing of the ascus wall). It must be noted that I have never observed an ontogenetic change of reactivity, not even a change in the type, when comparing the stages of development of Helotiales- or lichen asci.

My studies in Helotiales revealed that there have never been variations within a familiar species concerning the apical ring's type of reaction if different collections or conditions (fresh or dried, recent or up to 14 years old) were compared, except that transitional types, e.g. Bisporella: (r)b, sometimes showed an inconsistent shade of color in IKI (0.5-1% iodine) varying from pure grey to red-grey, while lower concentrations gave always blue. Likewise, I sometimes failed to observe the inconspicuous blueish shade in type r(b).

Melzer's reagent may give, ?as a rule, inconsistent results with non-pretreated rb-structures, while IKI, or KOH-pretreatment give consistent results. This is one argument that tells against the use of employing solely Melzer's reagent for diagnosing hemiamyloidity,

Within Helotiales, remarkable constancy was attributed to taxa of higher rank, e.g. by KORF (1962:15). This is even true for the subtypes of hemiamyloidity in certain genera: All studied species of Pezizula belong to type rr, all of Allophylaria to rb-0.12 (except some with inamyloid asci), both studied Belonidium-species to rb-0.15, Chloroscypha alutipes to rb-0.3, all studied Bisporella-species related to B. citrina to rb-0.5, and most species of e.g. Lachnum, Hymenoscyphus, Mollisia/Pyrenopeziza, and Sclerotiniaceae to type bb. However, other genera encompass nearly all possible types, e.g. Calycina: rr/rb-0.08 to 0.7/bb, Lachnellula: J-/rr/rb-0.1, Myriosclerotinia: rb/bb.

Hemiamyloidity occurs in most families of the Helotiales, but chiefly in the Dermateaceae (TAB. 6), and that predominantly in the Pezizuloidae, the Naevioideae, and the "Hysteropezizella-complex". The members of the latter group tend to show big guttulate ascospores and big apical rings including further characteristics, e.g. deposits on the paraphyse surface (HEIN 1981:464). The "Mollisia-Pyrenopeziza-complex" shows mostly minute eguttulate spores and minute apical rings, and no case of hemiamyloidity is known to me. This was also HEIN's experience who has found the red reaction in Dermateaceae to occur mainly in big apical rings (HEIN, in litt. 17.9.86). The type is often rr, whereas the other families show often type rb (TAB. 6). Minute hemiamyloid rings occur in the Hyaloscyphaceae.

Hemiamyloidity was used as a character on specific or generic level in the Helotiales e.g. by REHM (1896), DÉFAGO (1967), KOHN & KORF on Juniperus kindly received from G. J. KRIEGLSTEINER proved to react hemiamyloid, as does the collection (HB 3148 = PB 455) growing on Rubus-stems.

(1975), NANNFELDT (1976), and HEIN (1976), in the Sphaeriales (Hypocopra) by KRUG & CAIN (1974), in the Dothideales by DÖBBELER (1978 ff.), and in lichenized Ascomycetes in various publications of classical and recent workers.

DÖBBELER (1978:12) tested hundreds of fruit bodies and never observed any aberrant behaviour (the type is always? rr or nearly so except one species of Hypobryon being ?bb, DÖBBELER 1983). In the summary (1978:332) he stated: "This reaction is specific and has been found useful in indicating the relationship of certain species." POELT & VĚZDA (1977 & 1981) indicated the hemiamyloid reaction to be characteristic of a lot of lichen genera. E.g. Thelocarpon is said to show a strongly different behaviour among the species, their hymenial gels reacting either "rr" or "rb" (1977:251). HAFELLNER (1979:206) erected the new variety Schrakia crassula var. aurantiaca based merely on the hymenial gel that reacts red instead of blue as in the typical variation. VĚZDA (1968) and JØRGENSEN & VĚZDA (1984) found all species of the genera Thelopsis and Topelia to react "rb" while a related family, the Porinaceae, is said to be consistently J- to the present knowledge (1968:372). HENSSEN & BÜDEL (1984:384/385/Tab. 1) found the genus Phyllisciella of type bb ("deep blue reaction of the hymenial gelatine in iodine"), the genera Cryptothele, Phylliscidium, and Phylliscum of type rb ("a passing dirty blue tinge is observed which quickly changes into an intense vine-red"). There are certainly many more publications in lichenology that treat hemiamyloidity as a diagnostic feature.

The frequency of the hemiamyloid reaction varies strongly among the different orders of Ascomycetes. To the present knowledge, not a single species can be noted for Pezizales, a few for Sphaeriales, and ca. 15 % for Helotiales. Free-living Ostropales appear to show quite often type rb. Not a single species of non-lichenized non-bryophile Dothideales can be noted. On the contrary, lichenized and bryophile Ascomycetes show a comparatively high number of members with a hemiamyloid reaction: DÖBBELER (1978:12) stated the reaction to occur in more than 25% of the treated bryophile Pyrenomycetes while an euamyloid reaction is very rarely reported in this group. He was unable, however, to detect one Dothideales-species growing on true cormophyta that showed the reaction (all tested species showed persistent paraphysoids as did those bryophile species with inamyloid hymenial gel). The many species of Thelidium and Verrucaria (Verrucariales) show either "rr" or different kinds of "rb" (FÜSTING 1868, ZSCHACHE 1934). The frequent occurrence in the many orders of lichenized or lichenicol Ascomycetes is indicated when looking up books as MIGULA (1929/1931), KEISSLER (1930), or POELT & VĚZDA (1977/1981). TOBLER's statement (1925:114) is here confirmed, but only for the "layer c" of the lecanoralean ascus that was consistently found of type rb in each of the ca. 25 studied species.

This frequency of hemiamyloidity in lichenized fungi is the reason why lichenologists prefer using IKI instead of Melzer's reagent. The latter was found by Prof. J. POELT (pers. comm.) to be of little usefulness in that group.

	rr	rb	bb	J-	g	aw	th	a
PEZIZALES (residual)	--	--	--	xxx	x	-	-	-
-Ascobolaceae/Pezizaceae	--	--	xxx	xx	x	-	-	-
CYTTARIALES	?	?	?x	?x	-	-	-	x
-Dermateaceae (residual)	xxx 43	x 2	xx 6	xxx 3	-	-	-	x
-Mollisia/Pyrenop.-com.	--	--	xxx 45	x 5	-	-	-	x
Hyaloscyphaceae	x 6	xx 20	xxx 108	x 44	-	-	-	x
"Helotiaceae"	--	x 43	xxx 73	xx 20	-	-	-	x
Sclerotiniaceae	--	x 2	xxx 28	x 3	-	-	-	x
Vibrissea	--	--	x 2	x 1	-	-	-	x
Geoglossaceae	[?]		x 4	x 3	[x]	-	-	x
Hemiphacidiaceae: Hem.	--	--	--	xx	-	-	-	-
-Sarcotrochileae	--?	--?	x	--	-	-	-	x
-Phacidiaceae	--?	--?	x	--	-	-	-	x
RHYTISMATALES		[x]	--	xxx	-	-	-	[x]
OSTROPALES ¹	--	xxx?	x	x*	rb/bb	?		[bb]
GYALECTALES	?	x	x	?	rb	?		bb
PERTUSARIALES	x	?	?	?	x	?	(x)	-
LECANORALES ²	?	xxx	xxx	?	rb/bb	rb	±bb	-
PELTIGERALES	?	xx	xx	?	rb/bb	?	(bb)	bb
Dactylosporaceae	?	xx	xx	?	rb/bb	rb	-	-
LECANIDIALES	x?	x	x	x	rr?/rb	?	(bb)	-
ARTHONIALES	xxx	xx	xx?	?	x	-	-	(x)
OPEGRAPHALES	xx?	xx	--?	?	rr/rb	?	rr?	-
Epigloeaceae	x?		x	--	r/bb	?	-	-
VERRUCARIALES	xxx	xxx	?	?	x	-	-	-
PYRENULALES	x?		?	?	x	-	-	-
DOTHIDEALES (p. persist.)	--	--	--	xxx	-	-	-	-
-(paraphys. dissolving)	xxx	?	[x]	--	x	-	-	-
SPHAERIALES	--	x	xxx	xx	-	-	-	x
DIATRYPALES	?	?	?	?	-	-	-	x
HYPOCREALES	[x]	--	--	xxx	[x]	-	-	-

TAB. 6. Tentative table on frequency and location of the different types of hymenial amyloidity in the orders of Ascomycetes (and in the families of Helotiales). Frequency: left columns (the number of studied Helotiales-species is indicated). Location: right columns. Orders (or families resp.) devoid of any J+ species are omitted. Column "J-" indicates species entirely non-amyloid in the hymenium. xxx = frequent, x = rare, [x] = very rare; g = ascus gel, varying from a thin coat (no sign) to a thick intercellular matrix (▲), ▼ = phenomenon "lateral g:rb, apical g:bb" occurs; aw = layer c of the ascus wall; th = tholus, ▲ = an inner reactive layer occurs that reaches the base of asci; a = apical ring. 1) incl. Graphidales, 2) incl. Teloschistales.

* *Ostropa barbara* (Fr.) Nannf. (CS, GZU) was found entirely J-.

NANNFELDT (1976:283/284) considered the universally occurring amyloid ring to be primary in that Helotiales with inamyloid asci must have lost the ring during evolution (not the apical dome which is often also reduced). Furthermore, NANNFELDT considered the "provoked blueing" (hemiamyloidity) to be a first step in reduction. With the present knowledge, I am inclined to modify the latter hypothesis as follows: Hemiamyloidity must rather be considered an ancient and primitive feature because (1) it occurs most frequently in the lecanoralean ascus which is currently considered the ancestor ("archaeascus") of the various types of asci with active spore discharge, and (2) it occurs in a striking frequency in taxa associated with algae or mosses (in the latter case, the bryophile pyrenomycetes, euamyloidity is rather rare). Nevertheless, species with an hemiamyloid reaction may probably descend from ancestors with an euamyloid reaction as well if my theory proves true that euamyloidity is attained by a further step of synthesis.

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APPENDIX

Preliminary list of Ascomycetes with an hemiamyloid reaction (Helotiales are treated thoroughly on species level. Systematic is mainly according to the Dictionary of the Fungi (HAWKSWORTH et al. 1983).)

r = the mentioned author reported a reddish reaction

rr = red at any iodine concentration

rb = red at high, blue at low concentrations

rb-0.1 = red above, blue below 0.1 % iodine (IKI)

r(b)/(r)b = transitional types with inconsistent blue or red reaction resp.

bb = euamyloid (blue at any concentration)

M = the mentioned author observed the negative reaction in Melzer's reagent (or other reagents showing clearing effects) in non-pretreated material

(M) = faint reaction (blueish or greyish) in Melzer's reagent etc. (non-pretreated)

K = the mentioned author observed the KOH (NaOH)-induced (or enhanced) blueing

a = apical ring, th = tholus, aw = layer c of the ascus wall, g = hymenial gelatine, sg = gelatine of the subhymenium. Herbaria: see "Acknowledgements".

"HB" = the authors' herbarium

Hemiamyloidity of the ascus wall or the "hymenial" gelatine

HELOTIALES (a)

DERMATEACEAE

Belonium hystrix (DeNot.) v. Höhn. - Baral & Krieglsteiner 1985:28(r), HB 321(rr, M, K)

Coronellaria caricinella Karst. - Karsten 1869:105(r), Müller & al. 1963:189(r),

Baral & Krieglsteiner 1985:31(r), HB -(r, M, K)

delitschiana (Awd.) Karst. - Karsten 1869:105(r)

pulicaris Karst. - Karsten 1869:105(r), v. Höhn. (r, see Nannfeldt 1932:105)

typhae Nannf. - Nannfeldt 1932:107(r)

Dermata cerasi (Pers. ex Mèr.) Fr. - Bellemère 1967:600(r) (my collections, on

Prunus avium, HB 1231, 2976, are J-)

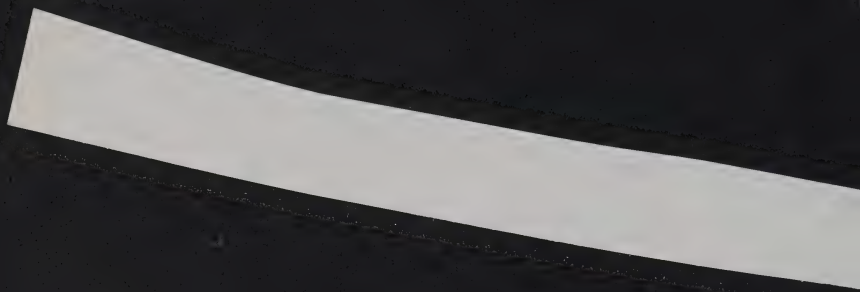
prunastri (Pers.:Fr.) Fr. - Rehm 1896:262(r, as "*Dermata vernicosa*")

tulasnei Groves - Rehm 1912:196(r, as "*Dermata fraxini*")

spp. - Kohn & Korf 1975:168(M, K)

- Diplonaevia caricis* (Petr.) Hein - Défago 1967:56(rb)
circinata (Lib.) Hein - Défago 1967:54(rb), CS, GZU (rb)
elynae (Défago) Hein - Défago 1967:57(rb)
exigua (Défago) Hein - Rehm 1912:144(r, as "Naevia rehmi")
salassorum (Défago) Hein - Défago 1967:51(r)
- Disco curtisia arundinaria* (Berk. & Curt.) Nannf. - Nannfeldt 1983:307(M, K)
Drepanopeziza paradoxoides (Rehm) Défago 1967:72(r), Rehm 1896:143(rb)
 "Drepanopeziza" *schoenicola* Graddon - Nannfeldt 1984:227(M, K)
- Hysteropezizella fuscilla* (Karst.) Nannf. agg. - FO 17936=HB 2980=BH/det.
 B. Hein (r(b), M, K), ?Rehm 1896:142 (rb, as "Naevia ignobilis")
 "Beloniella" *graminis* (Desm.) Rehm - Rehm 1896:643(rb)
 "Hysterozegiella" *hydrophila* (Bomm. & al.) Défago - Défago 1967:37(r)
phragmitina (Karst. & Starb.) Nannf. - Défago 1967:22(r)
pusilla (Lib.) Nannf. - Rehm 1896:143(r), Défago 1967:23(r)
 "Naevia" *stellariae* (Rostr.) Lind. - Hein 1976:112(rb)
subsessilis (Rehm) Nannf. - Défago 1967:25(r), :38 (rb, as "H. lapponica", p. p.)
subvelata (Rehm ex Rehm) v. Höhn. - Rehm 1896:156(rb), Défago 1967:15(rb), Rehm 1896:142(r, as "Naevia diminuens")
tetraspora (Rehm) Défago - Défago 1967:18(r)
valesiaca Défago - Défago 1967:21(r)
spec. (*Carex rostrata*) - CS, GZU (rr)
- Laetinaevia adonis* (Fuck.) Nannf. ex Hein - Hein 1976:38(r), HB 2889(rr, M, K)
alpina Petr. - Hein 1976:38(r)
carneoflavida (Rehm) Nannf. ex Hein - Hein 1976:45(r)
erythrostigma (Rehm) Nannf. ex Hein - Hein 1976:42(r)
spec. (*Dryopteris*) - PB 431=HB 3134(rr, M, K)
- Naevia minutissima* (Awd.) Hein - Rehm 1896:138(r), Hein 1976:91(r)
ribis Hein - Hein 1976:93(r)
- Naeviopsis jenensis* (Kunze ex Rehm) Hein - Rehm 1896:140(r)
pusilla (Speg.) Hein - Rehm 1896:138(r, as "Naevia carneopallida"), v. Höhnel 1917: 337(r, as "Pseudopeziza carneopallida")
simulans Hein - Hein 1976:80 (rb)
tithymalina (Kunze) Hein - Rehm 1896:139(rb), Hein 1976:66(r)
 "Merostictis" *hypopyrrha* (Rehm) Défago - Rehm 1896:162(r), Défago 1967:59(r)
- Ocellaria ocellata* (Pers.) Schroeter - Rehm 1896:134(r, as "O. aurea"), Belle-mère 1967:510(r), Breitenbach & Kränzlin 1981:216(r)
- Pezicula acericola* (Peck) Sacc. - Rehm 1896:1245(r), Kohn & Korf 1975:169(M, K), HB 1361(r(b), M, K)
alni (Rehm) Rehm - Rehm 1896:252(r), HB 3130=PB 429(rr, M, K)
aurantiaca (Rehm) Rehm - Rehm 1882:47(r), Rehm 1896:135(r)
australis (Rehm) Rehm - Rehm 1896:255(r)
betulae (Rehm) Rehm - Rehm 1896:1221(r)
carpinea (Pers.:Pers.) Tul. ex Fuck. - Rehm 1896:251(r), HB - (r)
cinnamomea (DeCand.:Pers.) Sacc. - Rehm 1896:253(r), HB 3110(rr, M, K)
eucrita Karst. (?=P. livida) - Rehm 1896:255(r), (cfr.) HB 1125(r(b), M, K)
frangulae (Fr.) Fuck. - Rehm 1896:260(r), Bellemère 1967:608(r)
laricicola Fuck. (?=P. livida) - Rehm 1896:254(r), Minks 1881:64(M, K)
linda Korf - Korf 1978: 489(M, K)
livida (Berk. & Br.) Rehm - Rehm 1896:256(r), Minks 1881:64(M, K), HB 1904, 2362, 2719(r(b), M, K)
myrtillina Karst. - HB 3073 (rr, M, K)
pallidula (Cke.) Rehm (?=P. corticola Nannf.) - Rehm 1912:199(r)
rubi (Lib.) Niessl. in Rabh. - Rehm 1896:258(r), Rehm 1896:259(r, as "Derma-tea rosae"), Minks 1881:64(M, K), Nannfeldt 1976:284(M, K)
sepium (Desm.) Dennis - Rehm 1912:198(r, as "P. crataegi")
spp. - Kohn & Korf 1975(M, K)
- Ploettnera coeruleoviridis* (Rehm) Henn. - Rehm 1896:539(r, as "Mollisia exigua"), v. Höhnel 1918:Fragm. 1097(r, as "P. exigua")
- Pseudopezicula tetraspora* Korf, Pearson & Zhuang - dto. 1986:468 (M, K), Korf in litt. (r)

age 162 line 15	for	~~dryina~~		
	19	for	A. dryina	~~dryinum~~
441	26	for	chrysophthalma"	Actinopelte dryina
	58	for	acicolum	chrysophthalma"
442	14	for	carpinicolus	acicola
				carpinicola



tracheiphila (Müll.-Thurg.) Korf & Zhuang - Korf, Pearson & Zhuang 1986:464
(M, K), Korf in litt. (r)

? genus (indet. coll., Lycopodium) - HB 3151=KE 653 (rb-0.15, M, K)

HYALOSCYPHACEAE

Belonidium leucostomum (Rehm) Raitv. - Rehm 1896:845 (rb), Huhtinen 1984:8 (M, K)
mollissimum (Lasch.) Raitv. - HB 2069 (rb-0.15, M, K)

sulphureum (Pers.:Fr.) Raitv. - Baral & Krieglsteiner 1985:67 (r), HB 1658 (rb-0.15, M, K), Bellemère 1967:832 (r)

Calycina conorum (Rehm) Baral in Baral & Krieglst. - HB - (rr, M, K)

cruentata (Karst.) O.Kuntze - HB 875 (rb-ca. 0.25, M, K)

discreta (Karst.) O.Kuntze - HH 10266 (r), HB 3068 (rb-0.3, (M), K)

herbarum (Pers.:Fr.) Gray - HB 1946 (rb-0.08, (M), K)

parilis (Karst.) O.Kuntze - HB 2975 ((r)b-0.7, (M), K)

? *Cistella*: "*Phialina*" *parenchymatosa* (Vel.) Graddon (cfr.) - HB 3103 (rb-0.15, M, K)

Dasyscyphus see *Belonidium* & *Lasiobelonium*

Hyalopeziza ciliata Fuck. - HB 857 (rb-0.2, M, K)

Incrucipulum ciliare (Schröd.:Pers.) Baral in Baral & Krieglst. - Matheis 1985b:
70 (M, K), HB 806b (rb-0.15, M, K)

virtembergense (Matheis) Baral in Baral & Krieglst. - Matheis 1977:241 (M, K),
HB 3071 (rr, M, K)

Lachnellula occidentalis (Hahn & Ayers) Dharne - Rehm 1896:832 (r, as "*Dasyscypha willkommii*"), Nannfeldt 1976:285 (M, K, as "*L. hahniana*"), Breitenbach & Kränzlin 1981:200 (r, as "*L. willkommii*"), Baral 1984:144 (r, K), HB 2978 (rr, M, K)

subtilissima (Cke.) Dennis - Matheis 1979:154 (M, K), Baral 1984:156 (r), HB 1966
(rb-0.12, M, K)

suecica (DeBary ex Fuck.) Nannf. - Rehm 1896:863 (rb, as "*L. chrysophthalma*"),

Baral 1984:156 (r), HB 2722 (rr, M, K), HB 1779 (rb-0.08, (M), K)

Lachnum albidroseum (Rehm) Nannf. - HB 3034 (rb-0.4, (M), K)

apalum (Berk. & Br.) Nannf. - Matheis 1985b:70 (M, K), HB - ((r?)b, (M), K)

Lasiobelonium corticale (Fr.) Raitv. - HB 2723 (rb-0.25, (M), K)

variagatum (Fuck.) Raitv. - HB 957 ((r?)b, (M), K)

Mollisia acerina (Mouton) v. Höhn. - HB 2956 (rb, M, K)

rubi v. Höhn. - HB 3033a (rb-0.15, M, K)

? *Proliferodiscus spec.* (Fagus) - HB 2996, 3002 (rb-0.15, M, K)

Protoungicularia brevicapitata Raitv. & Galan - PB 425=HB 3125 (rb-0.1, M, K)

Trichopezizella barbata (Fr.) Raitv. - Rehm 1896:854 (r), HB 2913 (rr, M, K)

relicina (Fr.) Raitv. - HB 2896 (rb-0.25, M, K)

Urceolella subgen. *Hyalacrotis*: "*Ungicularia*" *diaphana* (Rehm) Nannf. -
Rehm 1882:38 (r, as "*Naevia diaphana* var. *alpigena*"), Rehm 1896:140 (r),

Hein 1976:60 (r), v. Höhn. 1918:Fragn. 1080 (r, as "*U. alpigena*")

hamulata (Rehm) Korf & Kohn - Rehm 1896:534 (r), Korf & Kohn 1980:507 (M, K)

spec. (Veratrum) - Baral 1986:18 (r, M, K), HB 2897, 2927 (rr, M, K)

? genus: "*Dasyscyphus*" *dumorum* (Rob.) Massee - HB 3015 (rb-0.06, M, K)

LEOTIACEAE

Allophylaria subhyalina (Rehm) Baral in Baral & Krieglst. (tax. spec. a) - Baral
& Krieglsteiner 1985:94 (r), HB 2967, 3104 (rb-0.12, (M), K)

(tax. spec. b) - dto. 1985:94 (r), HB 932 (rb-0.12, (M), K)

(tax. spec. c) - dto. 1985:94 (r), HB 924 (rb-0.12, (M), K)

sublicoides (Karst.) Nannf. - dto. 1985:94 (r), HB 622 (rb-0.12, (M), K)

spec. (herbicol) - dto. 1985:95 (r), HB 2713 (rb-0.12, M, K)

spec. (graminicol) - dto. 1985:95 (r)

Bisporella citrina (Batsch:Fr.) Korf & Carp. - HB 2161 (rb-0.5, (M), K)

confluens (Sacc.) Korf & Bujakiewicz - Korf & Bujakiewicz 1985:307 ((M), K),

HB 802, 3089 (rb-0.5, (M), K)

drosodes (Rehm) Carp. - Rehm 1896:686 (r), (cfr.) HB 3106=HE 8145=MS ((r)b, (M), K)

iodocyanescens Korf & Bujakiewicz - Korf & Bujakiewicz 1985:305 (M, K)

lactea (Sacc.) Stadelmann - HB 2790 ((r)b-0.5, (M), K), Baral 1986:14 (r, M, K)

Cenangium aciculum (Fuck.) Rehm - Rehm 1896:228 (r), GK 098/83 (r, M, K)

- Chloroscypha alutipes* (Phill.) Dennis - HB 1984, 2425 (rb-0.3, M, K), Petrini 1982:210 (M, K)
chloromela (Phill. & Hark.) Seav. - Petrini 1982:210 (M, K)
sabinae (Fuck.) Dennis - Petrini 1982:213 (M, K)
 spp. - Kohn & Korf 1975 (M, K)
Geocoryne variispora Korf - Korf, Singh & Tewari 1978:146 (M, K)
Godronia fuliginosa (Fr.) Seav. - Bellemère 1967:614 (r)
Grovesiella ericae (Fr.) B. Eriksson - B. Eriksson 1970: 35 (M, (K)), Nannfeldt 1976:286 ((M), K)
Heterosphaeria patella (Tode:Fr.) Grev. - Rehm 1986:202 (r), Chadeaud 1942:67 (r)
patella var. *lojkae* Rehm - Rehm 1986:203 (rb)
linariae (Rabh.) Rehm - Rehm 1986:204 (r)
veratri Nespiak & Müller - HB 2886 (r(b)-0.08, M, K)
Hymenoscyphus carpinicolus (Rehm) Arendh. - Baral & Krieglsteiner 1985:123 (r), HB 2707 (rb-0.5, M, K)
 "Helotium" novum Vel. - Matheis 1985:62 (M, K)
Pezoloma ciliifera (Karst.) Korf - HB 3074 (r, M, K)
Phaeohelotium subcarneum (Schum. ex Sacc.) Dennis - Baral 1986:17 (r, M, K), HB 1104 (rb- 0.5, (M), K)
Velutarina rufoolivacea (Alb. & Schw.:Pers.) Korf - Rehm 1986:647 (r), Bellemère 1967:516 (r), HB 3148=PB 455 (rb-0.15, M, K), GK 096/83 (r, M, K, Juniperus)

GEOGLOSSACEAE

- Nothomitra cinnamomea* - Korf 1973:285/286 (?g/ol: M, K; a: euamyloid)

SCLEROTINIACEAE

- Ciboria bolaris* (Batsch:Fr.) Fuck. - HB 1732, 1764 (rb-0.5, M, K)
Ciborinia ciborium (Vahl:Fr.) Schum. & Kohn - Schumacher & Kohn 1985:1636 ((M), K)
Lambertella rhamnicola Batra - Batra 1968:1205 (r)
Myriosclerotinia sulcatula Schumacher & Kohn - Rehm 1986:820 (rb, as "Sclerotinia duriaana"), Schumacher & Kohn 1985:1631 ((M), K)
 some add. spp. - Schumacher & Kohn 1985 ((M), K)
 "Rutstroemia" paludosa (Cash & Davidson) Groves & Elliott - HB 3150 ((r)b, (M), K)
Sclerotinia minor Jagger - Kohn 1979:385 ((M), K)

SPECIES INCERTAE SEDIS

- Scelobolium melanosporum* (Rehm) v. Höhn. - Rehm 1986:747 (r)
 "Dermatea" piceae (Pers.) Rehm - Rehm 1986:257 (r)
 "Pirottaea" pini v. Höhn. - Rehm 1912:179 (r)
 "Naevia" rubella (Wint.) Rehm - Rehm 1986:140 (r), Hein 1976:112 (r)
 "Belonidium" schnablium Rehm - Rehm 1986:1228 (r)
 "Belonidium" subnivale Rehm - Rehm 1986:568 (r)
 "Naevia" tofjeldiae Rehm - Rehm 1986:142 (r)

? RHYTISMATALES (a)

(M, K)

- Arwidssonia empetri* (Rehm) B. Eriksson - Rehm 1986:73 (r), B. Eriksson 1974:199

OSTROPALES / (GRAPHIDALES) (g, ?aw, th/a)

- Absconditella* 7 spp. - Poelt & Vězda 1977:1 (r), Wirth 1980:80 (?th:r)
Bryophagus 2 spp. - Vězda 1966:168 (g, ?aw:rb, as "Gloeolecta")
Cryptodiscus foveolaris (Rehm) Rehm - Rehm 1986:159 (rb), Sherwood 1977:92 (M), HB 3147=PB 453 (rb-0.08, M, K; g/aw?)
pallidus (Pers.) Cda. - Rehm 1912:159 (rb), Sherwood 1977:90 (M/(M))
rhopaloides Sacc. - Rehm 1912:149 (rb), HB 3132=PB (g:rb-0.07, M, K; a:bb)
Diploschistes spp. - Poelt & Vězda 1981:84 (g:r)
 ? *Karstenia loniceriae* (Vel.) Sherw. - HB 3143=PB 456 (lateral g/?aw:rb-0.08, M, K; apical g/?aw, & reduced th: bb)
Ramonia luteola Vězda - Vězda lich. sel. exs. 654, GZU (g/?aw:rb, (M), K)
Stictis ?stellata Wallr. - HB 3144=PB (g:rb-0.07, M, K)
 spec. (Canary Islands) - HB 3156, 3157, 3158 (g:rb-0.07, M, K; apic. gel grains:bb)
Thelopsis 8 spp. - Vězda 1968 (g:rb)
Topelia 4 spp. - Jørgensen & Vězda 1984:502 (g:rb)

441	26	for	chrysophthalma"	read	chrysophthalma"
	58	for	acicolum	read	acicola
442	14	for	carpinicolus	read	carpinicola
443	47	for	"L. intumes-	read	"Lecidea intumes-
			~~acicolum~~		
442	14	for	carpinicolus	read	carpinicola
443	47	for	"L. intumes-	read	"Lecidea intumes-
444	55	for	personii	read	persoonii
445	8	for	nootkatenis (terrier)	read	nootkatensis (Terrier)
492	23	for	<i>E. canadensis</i>	read	<i>Elmynus canadensis</i>

(r)

GYALECTALES (g, ?aw, a)

Dimerella diluta (Pers.) Trevisan - HB 2176/det. Poelt (g/?aw:rb-0.03, (M), K; a:bb)

PERTUSARIALES (g, aw, th)

Coccotrema cucurbitula Mont. in Gay - Honegger 1982:215 (g, aw:r, K)

2 spp. - Brodo 1973:265/268 (r)

Lepolichen granulatus Müll. Arg. - Hue 1904 (r, K, acc. to Nannfeldt 1976)

LECANORALES/(TELOSCHISTALES) (g, aw, th)

Aspicilia cinerea (L.) Koerb. - Köhler 1968:36 (M, K, as "Lecanora c.")

Austrolecia antarctica Hertel - Hertel 1984:453 (aw?:r; th:bb)

Bacidia 3 spp. - Bertsch 1955:140/141 (rb)

Buellia punctata (Hoffm.) Massal. - Rehm 1896:353 (rb, as "Karschia thallophila")

Caloplaca lactea (Massal.) Zahlbr. - HB 3154a/aff. Hafellner (aw:rb-0.25, K; th, g, sg:bb)

spec. (Canary Islands) - HB 2224/aff. Hafellner (aw, ?th:rb-0.25, K; g, sg:bb)

Candelariella vitellina (Hoffm.) Müll. Arg. - HB 3042 (g, aw:rb-0.12, M, K; th:bb)

Catillaria ?18 spp. - Kilias 1981:254-257 (aw:rb, K; g:rb/bb?; K; th:bb)

spec. - Köhler 1968:28 (aw:M, K; th:bb)

Collema limosum (Ach.) Ach. - HB 3161 (lateral aw, ?g:rb)

Cryptothele spp. - Henssen & Büdel 1984:384/385 (g:rb)

Fuscidea 9 spp. - Oberhollenzer & Wirth 1984:547/548 (aw, ?g:rb; th:bb)

Herteliana taylori (Salw.) P. James - Poelt & Vězda 1981:161 (?M, K)

Hymenelia 9 spp. - Poelt & Vězda 1981:162 (?aw:rb, K)

Hypogymnia spp. (Canary Islands) - HB 2257/det. Hafellner (g, aw:rb; th:bb)

Lecanora campestris (Schaefer) Hue - HB 1644/det. Wirth (aw:(r)b-0.4; th, g, sg:bb)

conizaeoides Nyl. ex Crombie - HB 1645/det. Wirth (aw, th:rb-0.25, K; g, sg:bb)

crenulata (Dickson) Hooker - HB 3154/aff. Hafellner (aw, g, ?sg:rb-0.15, M, K; th:bb)

muralis (Schreber) Rabb. - HB 1643/det. Wirth (aw:(r)b-0.5, K; th, g, sg:bb)

Lecidea umbonata (Hepp) Mudd - HB 3091 = VW (aw:rb-0.15, K; g, sg:bb; th:J-)

(12 spp. - Bertsch 1955:153/154/160-162/167 (8x rb, 4x r))

Lecidella 4 spp. - Kilias 1981:257 (g:r; th:bb)

elaeochroma (Ach.) Hazsl. - HB 3010/aff. Wirth (aw, g:rb-0.08, M, K; th, sg:bb)

Lopadium hepaticola Döbbs., Poelt & Vězda - dto. 1985:83 (?aw:rb; g:bb)

Micarea ? 3 spp. - Poelt & Vězda 1977:157 (g: ?M, K)

subnigrata - Kilias 1981:257 (aw, g:r; th:bb)

Nesolechia oxysporella (Nyl.) Rehm - Rehm 1896:316 (rb)

Pannaria 4 spp. - Poelt & Vězda 1977:175-177/180 (rb)

Phylliscidium - Henssen & Büdel 1984:384/385 (g:rb)

Phylliscium - Henssen & Büdel 1984:384/385 (g:rb)

Physcia ?ciliata (Hoffm.) DuRoi - HB 3160 (aw, g:rb-0.1, M, K; th, ?sg:bb, M!, K)

Placopsis spp. - Lamb 1947 (r, acc. to Kilias 1981:258)

Protoblastenia rupestris (Scop.) Steiner - HB 3153/aff. Hafellner (aw, g:rb-0.15, M, K; th, g, sg:bb)

Psora spp. - Poelt & Vězda 1981:99 (?aw:rb; th:bb)

Ptychographa flexella (Ach.) Coppins - Rehm 1896:313 (rb, as "Placographa f.")

Pyrenopsis 2 spp. - Bertsch 1955:212 (rb)

Rhizopla melanophthalma (Ram.) Leuck & Poelt - HB 2282/aff. Hafellner

(aw, g:rb-0.15, M, K; sg, ?th:bb, (M), K) cens")

Rimularia insularis (Nyl.) Rambold & Hertel - Rehm 1896:321 (rb, as "L. intumes")

Rinodina bischoffii (Hepp) Massal. - HB 3035/aff. Hafellner (aw, g:rb-0.12, (M), K; th:rb-0.2, (M), K)

spec. - Kilias 1981:257 (aw, g:r, th:bb)

Saccomorpha icmalea (Ach.) Clauz. & Roux - HB 3063 = PD 5558/det. Wirth

(?aw, g:r(b), M, K; th:J-), Hafellner 1984:334 (?aw:rb, as "S. uliginosa")

Scutula epiblastematica (Wallr.) Rehm - Velenovský 1934:76 (rb)

5 spp. - Rehm 1896:322-326 (4x rb, 1x r)

Thelocarpon laureri (Flotow) Nyl. - Bertsch 1955:184 (r, as "T. prasinellum")

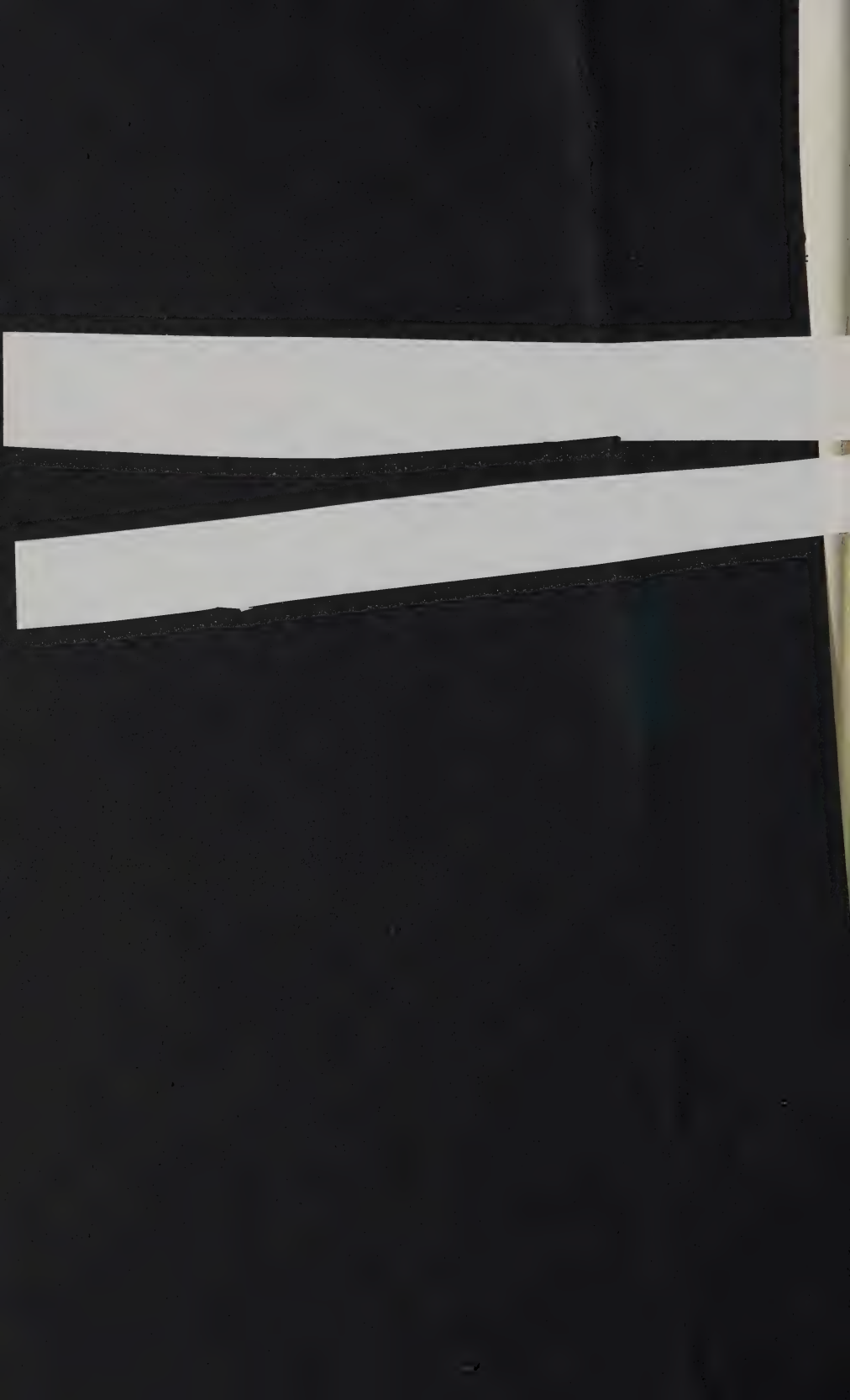
coccosporum Lettau - Wirth 1980:481 (g:r)

spp. - Poelt & Vězda 1977:251 (g/?th:rb or rr)

- Trapelia coarctata* (Sm. & Sow.) Choisy - Scheidegger 1985:200 (?aw:r, K), Honegger 1982:215 (aw:r, K; g:r, dissolved in KOH), Hertel in Köhler 1968:17 (M, K), Chadeaud 1973:133 (?aw, g:rb), HB-/leg. Wirth (aw, g, th:r, K)
- Tremolecia atrata* (Ach.) Hertel - Poelt & Vězda 1981:335 (?g:rr, K; th: J-) Umbilicaria spec. - HB 2290 (aw, g, sg, ?th:rb, K)
- Vezdaea obscura* Döbb. - Döbbeler 1981:461 (aw, ?th:rb, K)
- Wadeana* 2 spp. - Poelt & Vězda 1981:335 (g:K) bb)
- Xanthoria elegans* (Link) Th. Fr. - HB 2275/aff. Hafellner (aw:rb-0.25, K; g, sg, ?th: parietina (L.) Th. Fr. - HB 3036/aff. Wirth (aw:rb-0.25, K; g, sg:bb; th:?(r)b, M, K)
- PELTIGERALES** (g, aw, th, a)
- Peltigera praetexta* (Sommerf.) Zopf - HB 1789/det. Wirth (lateral aw/g:(r)b-0.3, K; apical aw/g, & a:bb)
- Polychidium muscicola* (Swartz) Gray - HB 2269/det. Hafellner (lateral aw/g:rb-0.25, (M), K; apical g:rb/bb; minute th, sg:bb)
- Solorina saccata* (L.) Ach. - HB 1795/aff. Wirth (aw/g:rb-0.2, M, K; th, a:bb)
- LECANIDIALES** (aw/g, th)
- Catolechia wahlenbergii* (Ach.) Flot. - Poelt & Vězda 1977:43 (aw/g:r; th:bb)
- Epilichen* 2 spp. - Poelt & Vězda 1981:149 (aw/g:rb; th:bb)
- ARTHONIALES** (aw/g, th)
- Arthonia calamicola* (Syd.) R. Sant. - R. Santesson 1952:89/90 (?aw:r, K; g:r, dissolved by KOH)
- lurida* Ach. - HB 3018 = VW 6077 (aw/g:rr, M, K), Redinger 1937:107 (r)
- fuscopurpurea* (Tul.) Sant. - R. Santesson 1960:501 (rr), Rehm 1896:325 (rb)
- many spp. - Almquist 1880 (rr or rb), Redinger 1937 (r/rb), Bertsch 1955:193-195 (r), Rehm 1896:422, 424, 426-430 (5x rb, 1x r, as "Celidium" or "Conida")
- "*Lecideopsis*" *bueriana* (Lahm) Rehm - Rehm 1896:433 (rb)
- Arthothelium* 2 spp. - Rehm 1896:439/444 (r)
- Dawsonophila callichroma* Döbb. - Döbbeler 1981:436 (g/th:rb, M, K)
- pygmaea* Döbb. - Döbbeler 1981:440 (g/th:r, M, K)
- Melaspilea proximella* Nyl. ex Norlin - Rehm 1896:364 (r)
- OPEGRAPHALES** (aw/g, th)
- Lecanactis abietina* (Ach.) Koerb. - Köhler 1968:28 (aw/g:rb, th:rr, K)
- many spp. - Kurokawa 1969:689 (r, K)
- Opegrapha* 4 spp. - Sérusiaux 1985:19/20 (r)
- 2 spp. - Rehm 1896:376/380 (rb, as "*Leciographa*")
- VERRUCARIALES** (g, th)
- Agonimia tristicula* - Döbbeler 1978:13 (g:r, K)
- Dermatocarpon rufescens* (Ach.) Th. Fr. - Bertsch 1955:218 (r)
- Leucocarpia biatorella* (Arnold) Vězda - Poelt & Vězda 1981:204 (g, th:r)
- Macentia abscondita* B. Coppins & Vězda - Poelt & Vězda 1981:207 (g, th:r)
- Muellerella* 2 spp. - Döbbeler & Triebel 1985:504-509 (g:r, K)
- pygmaea* (Koerb.) D. Hawksw. - Döbbeler 1978:13 (g:r, K, as "*Tichothecium* p.")
- lichenicola* (Sommerf. ex Fr.) D. Hawksw. - Killias 1981:259 (g:rb)
- Phaeospora* spp. - Döbbeler & Triebel 1985:509 (g:r, K)
- Polyblastia* 7 spp. - Döbbeler 1978:13 (g:r, K)
- Thelidium absconditum* (Loerb.) Rabh. - Füsting 1868:662 (g:rb)
- umbrosum* Massal. - Füsting 1868:662 (g:rb)
- Verrucaria* ? *floerkeana* D. T. & Sarnth. - HB 3040 (g:rr, M, K)
- schaereri* Nyl. - Füsting 1868:660 (g:rb, as "*Endopyrenium monstuosum*")
- many spp. - Bertsch 1955:236-242 (mostly r, rarely rb)
- many spp. of this order - Zschacke 1934:46-668 (rb or rr)
- PYRENULALES** (?g)
- Pyrenula punctifera* - Kurokawa 1969:689 (r, K)
- DOTHIDEALES** (g)
- Arthopyrenia personii* Massal. - Bertsch 1955:223 (r)

				read	acicola
442	14	for	carpinicolus	read	carpinicola
443	47	for	"L. intumes-	read	"Lecidea intumes-
444	55	for	personii	read	persoonii
445	8	for	nootkatenis (terrier)	read	nootkatensis (Terrier)
492	23	for	<i>E. canadensis</i>	read	<i>Elymus canadensis</i>

444	55	for	personii	read	persoonii
445	8	for	nootkatenis (terrier)	read	nootkatensis (Terrier)
492	23	for	<i>E. canadensis</i>	read	<i>Elymus canadensis</i>
	24	for	<i>A. hiemalis</i>	read	<i>Agrostis hiemalis</i>
				read	<i>Enichloe typhina</i>



Bryopelta variabilis Döbb.&Poelt - Döbbeler 1978:12 (r, M, K)
Endococcus spp. - Döbbeler&Triebel 1985:509 (r)
Epibryon 25 spp. - Döbbeler 1978:12/1979:193 (r, M, K)
 musculicola (Racov.) Döbb. - HB 3142= PD 4870 (r(b), M, K)
Hypobryon 4 spp. - Döbbeler 1983:3/4 (r, K)
Julella 3 spp. - Döbbeler 1978:12 (r, M, K)
Karschia santessonii Haf. - Hafellner 1979:182 (rr, K)
Pseudodiscus nootkatenis (terrier) v. Arx & Müller - Hafellner 1979:194 (rr)
Punctillum 3 spp. - Döbbeler 1978:12, 1979:219 (r, M, K)
Schrakia crassula (Starb.) Haf. var. *aurantiaca* Haf. - Hafellner 1979:206 (rr)
 ?genus: "*Pleospaeria*" *haploziae* Racov., "*Pl.*" *lophoziae* Racov., "*Pleospora*" *hepaticola* Watson, "*Teichospora*" *jungermannicola* (Mass.) Sacc. - Döbbeler 1978:326/327 (r, M, K)

SPHAERIALES (a)

Hypocopra equorum (Fuck.) Winter - HB 2971 (r, M, K)
 spec. (rabbit dung) - HB 3145 (rb-0.2, (M), K)
 spec. - Nannfeldt 1976:284 (M, K)
 6 spp. - Krug&Cain 1974:811 (rb; two species a_s :rb, a_i :?bb)
Hypoxylon serpens (Pers.:Fr.) Fr. - Munk 1957:132 (r), Parguey-Leduc 1977:324 (r), O. Eriksson 1966:315 (M, K), Pouzar in Nannfeldt 1976:284 (M, K), Petrini & Müller 1986:553 (M, K)
Rosellinia spec. - Parguey-Leduc 1977:324 (r)

HYPOCREALES ([g])

Calonectria celata Döbb. - Döbbeler 1978:12 (g:r, M, K)

GENERA INCERTAE SEDIS

Dactylospora heimerlii (Zukal) Döbb.&Trieb. - Döbbeler&Triebel 1985:511
 (lateral ol: rb, K; apical ol: bb)
 rimulicola (Müll.Arg.) Haf. - Rehm 1896:352 (rb, as "*Karschia r.* (Sacc.)")
 stygia (Berk.&Curt.) Haf. - Rehm 1896:347 (rb; as "*Karschia nigerrima*")
 spec. - HB 2992a/det. Hafellner (lateral g/aw:rb-0.1, M, K; apical g/aw:bb)
Epigloea bactrospora Zukal & Vězda - Poelt & Vězda 1981:148 (r), Zschacke 1934:
 several spp. - Döbbeler 1984:208 (?rb, K) 46 (r)
Mosigia gibbosa (Ach.) Koerb. - Poelt & Vězda 1977:167 (?aw/g:rb; ?th:bb)
Sarcosagium campestre (Fr.) Poetsch & Schiederm. - HB 2453/aff. Hafellner
 (aw/g:rb-0.4, K; g, sg, a:bb)

Hemiamyloidity of structures of the excipulum and ascospores

HELOTIALES: *Perrotia flammea* (Alb.&Schw.:Fr.) Boud. - HB 3146=PB 443 (ectal excip., intercellular gel: rr, M, K)
Proliferodiscus pulveraceus (Alb.&Schw.:Fr.) Baral in Baral&Krieglst. - v.Höhnelt 1917 (r; acc. to Dennis 1949:58), HB 3149 (rr, M, K): as in *P. flammea*
 "Hymenoscyphus" *erythropus* Döbb. - Döbbeler 1981:459 (excipular cell walls, especially near stipe: r, M, K)
DOTHIDEALES: *Epibryon pogonati-urnigeri* Döbb. - Döbbeler 1981:453 (excipular cell walls in the ostiolum: r, M, K)
ARTHONIALES: *Dawsophila pygmaea* Döbb. - Döbbeler 1981:440 (mycel/gel of the whole ascocarp: r, M, K)
 callichroma Döbb. - Döbbeler 1981:436 (gel of whole ascocarp: rb, M, K)
Bryostigma leucodontis Poelt&Döbbeler - Poelt&Vězda 1981:104/117 (whole haploid ascocarp: r, K)
GENUS INCERTAE SEDIS: *Obtectodiscus aquaticus* Müller, Petrini&Samuels - dto. 1979 (r), HB 2972=EM (ascospore wall surface & appendages: rr, M, (K))
Loramycetes macrospora Ingold & Chapman - CS, GZU (ascosp. gelat. coat:rr, M, K)

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**STAGONOSPORA HETERODERAE, A NEW SPECIES ISOLATED FROM
CYSTS OF HETERODERA GLYCINES**

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During studies on the fungi associated with cysts of the plant-parasitic nematode *Heterodera glycines* Ichinohe in various agricultural soils in the midwestern and southeastern United States, and in the Cauca Valley, Colombia, we encountered a species of *Stagonospora* (Sacc.) Sacc. which we believe to be hitherto undescribed. Herein we describe this fungus as a new species.

The fungus was isolated from *H. glycines* cysts extracted from soybean field soil in Illinois using a wet-seiving technique (Southey, 1970). Cysts were surface-sterilized 3 min in 0.5% NaOCl, rinsed in sterile water, and placed on water agar (Bacto-Agar, Difco, Detroit, MI). Subcultures were made from fungal mycelium growing from cysts. Cultures were maintained on Difco corn-meal agar (CMA) and subjected to fluorescent light (about 10 h daily) at 22-26 C. Fungi were isolated from cysts originating elsewhere using techniques described previously (Morgan-Jones et al., 1981).

Stagonospora heteroderae sp. nov., Figs. 1-7.

Coloniae in agaro cum Zeae farina composito cultae die octava diametrum 0.7-2 cm attingentes, mycelio ex albo pallide grisescente vel roseo, laneo vel funiculoso. Coloniae heptomade undecima pallide griseae, saepe pigmentum roseum vel rubrum in agaro efficientes. Pycnidia nigra, globosa, setosa, plerumque in agaro immersa, singula vel aggregata, 208-460 μ m diametro; parietes ex textura

angulari, 3-4 cellulis crassi, cellulis exterioribus atro brunneis. Cellulae conidiogenae phialidicae, circum canalicum centralem incrassatae, nonnumquam percurrenter proliferantes, hyalinae, inter doliiformes et globosas ambiguae, 6.4-11.2 X 3.2-5.6 μm . Conidia hyalina vel subhyalina, raro pallide brunnea, tenuiter tunicata, levigata, fusiformia vel cylindrica, plerumque triseptata, guttulata, 18.4-27.6 X 4-6.4 μm . Chlamydosporae e subhyalino fusce brunneae, globosae, crasse tunicatae, levigatae vel verruculosae, intercalares, catenatae, 7.2-12 μm .

Isolatus e cystis *Heterodera glycines* e terra, Sidney, Champaign Co., Illinois, August 22, 1985, L. M. Carris, ILLS, holotypus.

Seven-da-old colonies on CMA 0.7-2 cm diam, white, pale gray to pink, aerial mycelium woolly to funiculose, border even, reverse pale gray to pink. Ten-wk-old colonies on CMA covering plates, pale gray, often with pink to red pigment in agar under central portion of colony, dark gray to black areas with chlamydospores and pycnidia forming irregularly in agar, aerial mycelium felty to woolly, irregularly appressed to floccose, reverse pale gray to red, with dark gray to black areas. **Pycnidia** (Fig. 1) black, globose, setose, mostly immersed, solitary or aggregated; 208-460 μm diam, wall **textura angularis**, 3-4 cells thick, outer cells dark brown; forming after 1-2 months in culture. **Conidiogenous cells** (Figs. 2-5) phialidic with periclinal thickenings (Figs. 2, 3), hyaline, doliiform to globose, with necks of varying length; arising from inner wall of pycnidium, separating readily from wall in squash mounts; occasionally proliferating percurrently, often forming gelatinous material at base of developing conidium (Fig. 5), 6.4-11.2 X 3.2-5.6 μm . **Conidia** (Fig. 6) hyaline to subhyaline, rarely becoming pale brown, thin-walled, smooth, fusiform to cylindrical, mostly 3-septate, with conspicuous lipid drops; 18.4-27.6 X 4-6.4 μm . **Chlamydospores** (Fig. 7) subhyaline to dark brown, globose, with thick (0.8 μm) walls, smooth to verruculose, intercalary, in chains; 7.2-12 μm diam; forming in clusters in agar, rarely in aerial mycelium.

In cysts of *Heterodera glycines*; Colombia and USA.

Isolates examined: Colombia: La Floresta, Palmira and ICA, Molina, November 1983, G. Morgan-Jones, AUA. USA: ARKANSAS: Marianna, Lee Co., July-August, 1981, G. Morgan-Jones, AUA; FLORIDA: Jay, Escambia Co., July-August 1981, G. Morgan-Jones, AUA; ILLINOIS: Dix, Jefferson Co.,



Figs. 1-7. *Stagonospora heteroderae*. 1. Pycnidia from culture, X40. 2, 3. Conidiogenous cells with periclininal thickenings (arrows). 4. Conidiogenous cell with developing conidium. 5. Conidiogenous cell with developing conidium and gelatinous substance (arrow) at base of conidium. 6. Conidium. 7. Chain of chlamydospores. All X2090 unless otherwise noted.

seven isolates at various dates June-October, 1983-1985, L. M. Carris, ILLS; Sidney, Champaign Co., September 1983, L. M. Carris, ILLS, living culture deposited with ATCC; MISSISSIPPI: Pontotoc Co., July-August, 1981, G. Morgan-Jones, AUA; MISSOURI: Lee Farm, Pemiscot Co., July-August, 1981, G. Morgan-Jones, AUA.

Although Sutton (1980) described conidiogenous cells of *Stagonospora* as being holoblastic and occasionally annellidic, more recently he (Sutton, 1986) described *S. clandestina* Sutton as sometimes forming distinct periclinal thickenings. The common periclinal thickenings, and occasional percurrent proliferations, formed by *S. heteroderae* indicate that similar mechanisms of conidial ontogeny are operative in it. This species previously was reported as "*Stagonospora heteroderae* in ed." (Morgan-Jones *et al.*, 1981).

Stagonospora heteroderae often is associated with cysts and eggs of *H. glycines* in soybean field soils. It was isolated from 6.7% of the approximately 5,000 *H. glycines* cysts examined from two Illinois fields, making it one of the most commonly isolated species there. In Arkansas, Florida, Missouri, and Mississippi, 11.3%, 15.2%, 9.6%, and 10.4%, respectively, of the cysts examined were colonized by *S. heteroderae*. In these states, 21.2%, 23.6%, 18.9%, and 20.2%, respectively, of cysts colonized by fungi contained this species. In Colombia the fungus was isolated from 1.8% of cysts examined, and it occurred in 4.7% of those colonized by fungi.

Stagonospora heteroderae appears to have a wide geographical distribution and is one of the more common fungi occurring in cysts of *H. glycines*. Its less frequent occurrence in cysts of Colombian origin may indicate that it is not well established in soybean fields in that country, or that it may only recently have been introduced with the nematode. Before 1983, *H. glycines* was not known to occur in South America (Tovar and Medina, 1983; Morgan-Jones *et al.*, 1984). Although widespread in distribution, *S. heteroderae* does not seem to occur in cysts of *H. glycines* in all areas where soybeans are grown. Gintis *et al.* (1983), for example, did not find the fungus during an extensive survey of the mycoflora of *H. glycines* cysts in Alabama.

Whether or not *S. heteroderae* functions as an effective pathogen of *H. glycines* and participates in suppressing nematode populations remains to be determined. Cysts penetrated by hyphae of the fungus often are occupied by masses of brown chlamydospores, and the fungus sometimes

forms pycnidia in or on decaying cysts. Morgan-Jones **et al.** (1981) reported it to be present within eggs dissected from colonized cysts. In such eggs, larvae were largely obliterated. Further studies on the parasitism of **H. glycines** by the fungus seem warranted.

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A SCLEROTIUM-PRODUCING *HYPHOLOMA* FROM BRITISH COLUMBIA

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ABSTRACT

Hypholoma tuberosum sp. nov. is described from mulch beds and compost piles in Vancouver, British Columbia. Unusual characteristics of the species are the development of sclerotia, dextrinoid chlamydospore-like segments in the mycelium, and a pronounced "earthy" odor in culture. A neotype is selected and described for *Stropharia tuberosa* Beardslee.

INTRODUCTION

A new species of *Hypholoma*, collected repeatedly on compost piles and mulch beds in Vancouver, British Columbia, is characterized by a short to long radicating stipe (Figs. 2-3) and the presence of a conspicuous subterranean sclerotium (Figs. 1-2). Apparently no other species of *Hypholoma* form sclerotia, however, certain species in other genera of the Strophariaceae, *Psilocybe* and *Stropharia*, produce them.

ISCC-NBS colours are indicated by capital letters (Kelly 1965).

Hypholoma tuberosum Redhead & Kroeger, sp. nov.

Figs. 1-12

Pileus 15-60 mm lat., convexus, subumbonatus, armeniacus vel croceus, humidus vel subviscidus, opacus. Lamellae adnexae, vinoso-bubalinae, murinascens. Stipes 40-55 mm long., 2.5-4 mm lat., ochraceae. Velum luteolum, arachnoideum, superum. Pseudorrhizoma molle, vinoso-bubalinum. Sclerotium irregulare, brunneolum, ad 85 x 50 x 45 mm. Basidiospores 9.5-11.5 (-12.8) x 5.2-7 (-7.8) μ m, anguste ovoideae vel ellipsoideae, violaceo-brunneae, leves, cum poris apicalibus. Basidia 27-30 x 8-9 μ m, tetraspora. Chrysocystidia 40-49 x 10-15 μ m, ventricosa vel fusiformes. Cheilocystidia 30-38 x 5.5-8.5 μ m, ventricosa vel cylindracea, hyalina. Caulocystidia 45-55 x



6-10 μm , fusiformes vel cylindracea, irregulares, hyalina. Hyphae fibulatae.

In quisquiliis hortorum.

HOLOTYPE: DAOM 191755 (P. Kroeger No. 804)

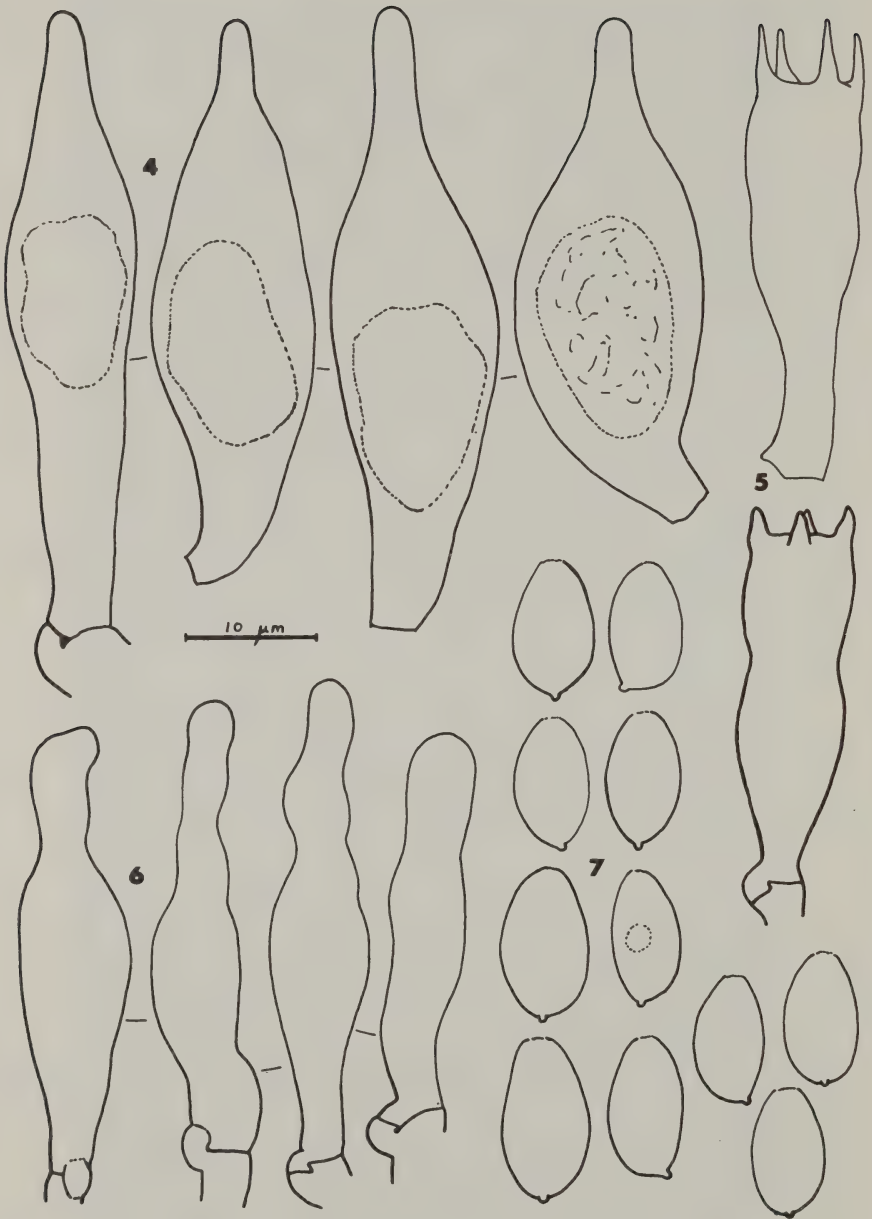
Pileus 15-60 mm diam, convex and subumbonate, becoming convex; margins tightly incurved when young, joined to the stipe by a densely arachnoid veil at first; colour between BROWN ORANGE and DEEP ORANGE centrally, LIGHT ORANGE to ORANGE YELLOW marginally; surface opaque except for marginal areas on overly mature specimens and then slightly striate, moist to subviscid. Context fleshy slightly lighter than LIGHT YELLOW BROWN; taste slightly bitter; odor faintly farinaceous. Lamellae adnexed with or without a short decurrent tooth, subdistant, LIGHT GREY YELLOW BROWN when immature, becoming GREY YELLOW BROWN with whitish edges. Stipe 40-55 mm long, 2.5-4 mm wide, tapered upwards slightly, sometimes abruptly swollen at the surface of the soil, tapered below into a short to long radicate pseudorrhizae leading to a subterranean sclerotium, or directly arising from a sclerotium; colour ORANGE YELLOW to LIGHT ORANGE YELLOW, becoming ochraceous where bruised or handled; surface ornamented by a superior arachnoid to fibrillose whitish veil when young, which is soon darkened by basidiospores, below the annular zone sometimes subviscid in wet weather and these specimens when dried appearing subvarnished, overlaid by scattered yellowish fibrils or fibrillose patches or bands, above the annular zone minutely fibrillose. Context concolorous or paler than the surface, tough, nearly woody near the substrate surface, stuffed. Pseudorrhizae soft, up to twice the length of the stipe; colour near LIGHT GREY YELLOW BROWN.

Sclerotia irregular, often lobed, subglobose, ellipsoid or oblong, up to 85 x 50 x 45 mm, formed at the soil-mulch interface; colour BROWN; surface covered with a thin tough dry outer rind; interior colour GREY YELLOW BROWN to DARK GREY YELLOW with some ochraceous areas; odor earthy to somewhat like green corn; taste slightly raphanoid or mild.

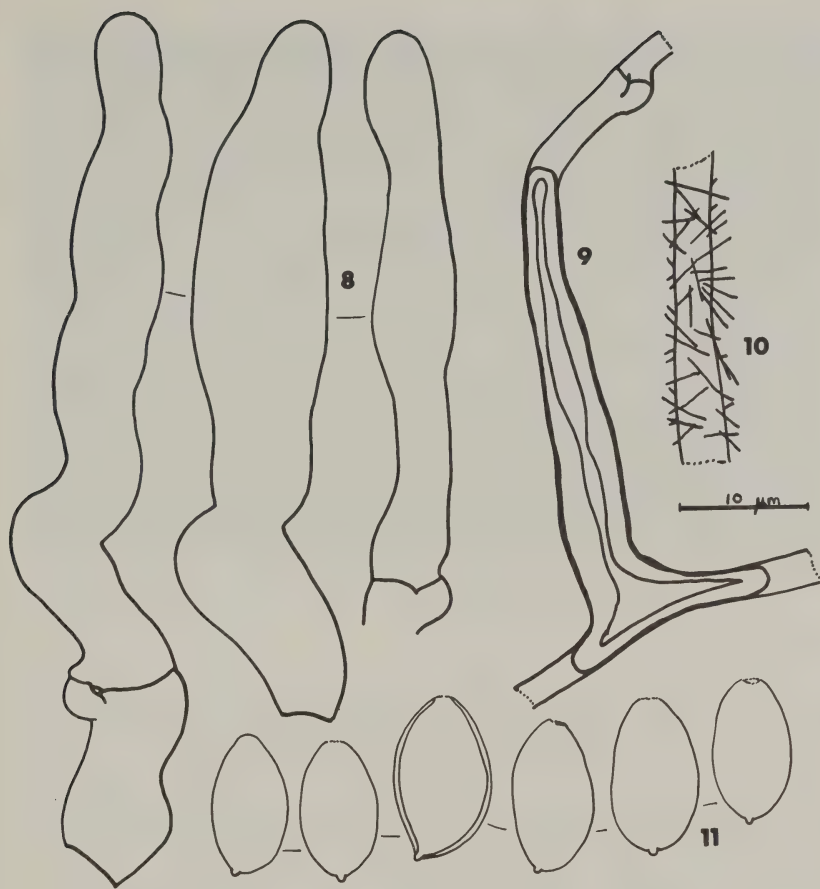
Spore deposit DEEP GREY BROWN (brown vinaceous).

Pileipellis approximately 100 μm thick; hyphae filamentous, 2.5-5 μm diam, thin-walled, clamped, finely incrustated with pale yellowish brown pigments, embedded in a thin gelatinous matrix. Subpellis approximately 120 μm thick composed of swollen cigar-shaped to subglobose cells 10-20 μm diam, with greater pigmentation and incrustation than the pileipellis. Pileus trama hyphae 5-10 μm diam, somewhat interwoven, filamentous, with mostly smooth, hyaline, slightly thickened walls, clamped. Lamellar trama regular, hyaline, the hyphae 5-12 μm diam, similar to those in the pileus trama; subhymenium subcellular, approximately 20 μm thick, the cells 4-5 μm diam. Basidiospores (Figs. 7, 11) 9.5-11.5 (-12.8) x 5.2-7 (-7.8) μm , narrowly ovoid to ellipsoid in face view, slightly inequilateral in profile, smooth, with slightly thickened violaceous brown walls and a

Figs. 1-3. *Hypholoma tuberosum* basidiomes. Fig. 1. DAOM 191753, ca. x 0.5 Fig. 2. DAOM 191711, ca. x 0.3. Fig. 3. DAOM 191746, ca. x 0.3.



Figs. 4-7. *Hypholoma tuberosum*, DAOM 191755. Fig. 4. Pleurocystidia (chrysocystidia). Fig. 5. Basidia. Fig. 6. Cheilocystidia. Fig. 7. Basidiospores. Scale = 10 µm.



Figs. 8-11. *Hypholoma tuberosum*, DAOM 191755. Fig. 8. Caulocystidia. Fig. 9. Dextrinoid chlamydospore-like unit in mycelium. Fig. 10. Crystal coated hyphal segment. Fig. 11. Basidiospores. Scale = 10 μm .

faint apical germ pore. Basidia (Fig. 5) 27-30 x 8-9 μm , 4-spored, clamped, hyaline, suburniform, prominently projecting when mature. Pleurocystidia (chrysocystidia) scattered, abundant, 40-49 x 10-15 μm , fusoid to fusoid-ventricose, thin-walled, hyaline or occasionally yellowish, mostly embedded in the hymenium (Fig. 4). Cheilocystidia (Fig. 6) 30-38 x 5.5-8.5 μm , obtusely ventricose to cylindrical, often with an undulate neck, thin-walled, smooth, hyaline. Caulocystidia (Fig. 8) 45-55 x 6-10 μm , irregularly cylindrical to fusoid, hyaline, thin-walled, obtuse. Stipitipellis hyphae parallel, 3-5 μm diam, hyaline to faintly yellowish. Stipititrama hyphae up to 15 μm diam, monomitic, in the pseudorrhizae the occasional ellipsoid cell swollen to 40 μm diam. Sclerotial rind covered with matted interwoven filaments 2-3 (-4.5) μm diam, with brownish slightly thickened walls;



Fig. 12. *Hypholoma tuberosum*, DAOM 196967, basidiomes slightly magnified.

the cortex composed of intricately interwoven hyphae 2-8 μm diam, with brown thick walls. Sclerotial trama of highly convoluted, interwoven hyphae 5-8 μm diam, with hyaline thick ($\sim 2 \mu\text{m}$ thick) walls.

Mycelium in culture isolated from a sclerotium (DAOM 191711), and on dried specimens, hyaline, composed of filamentous, clamped hyphae covered by long bacilliform hyaline crystals in some segments (Fig. 10), in other segments forming thick-walled, intercalary, often T-shaped, chlamydospore-like units up to $40 \times 5 \mu\text{m}$ (Fig. 9), with dextrinoid walls to 2 μm thick in places. Odor in culture strong and "earthy", similar to that produced by some actinomycetes.

Habit and Habitat: solitary to cespitose, directly attached to shallowly buried sclerotia or attached to deeply buried sclerotia by elongated pseudorrhizae, in compost piles, rank grass, mulched gardens, and loose soil extensively burrowed by mammals in parks in Vancouver (west coast maritime climate).

Collections examined: Canada, British Columbia, Vancouver: Stanley Park, Sept. 19, 1982, P. Kroeger 339 (DAOM 191752); Univ. B.C. botanical gardens, Sept. 23, 1984, P.K. 799, 800, 801, 802 (DAOM 198975, 198976, 191746, 191711), Sept. 25, 1984, P.K. 803, 804 (Holotype), 805 (DAOM 198974, 191755 Holotype, 191757), Sept. 30, 1984, P.K. 807 (DAOM 191753), Oct. 11, 1984, P.K. 814 (DAOM 198973), Sept. 10, 1985, P.K. 865, 866 (DAOM 198972, 198971), Oct. 1, 1986, P.K. 1058 (DAOM 196967). Duplicates of all but P.K. 339 will be deposited at UBC.

It is possible that *H. tuberosum* has been recently introduced into the Vancouver area. Its restriction to cultivated gardens or

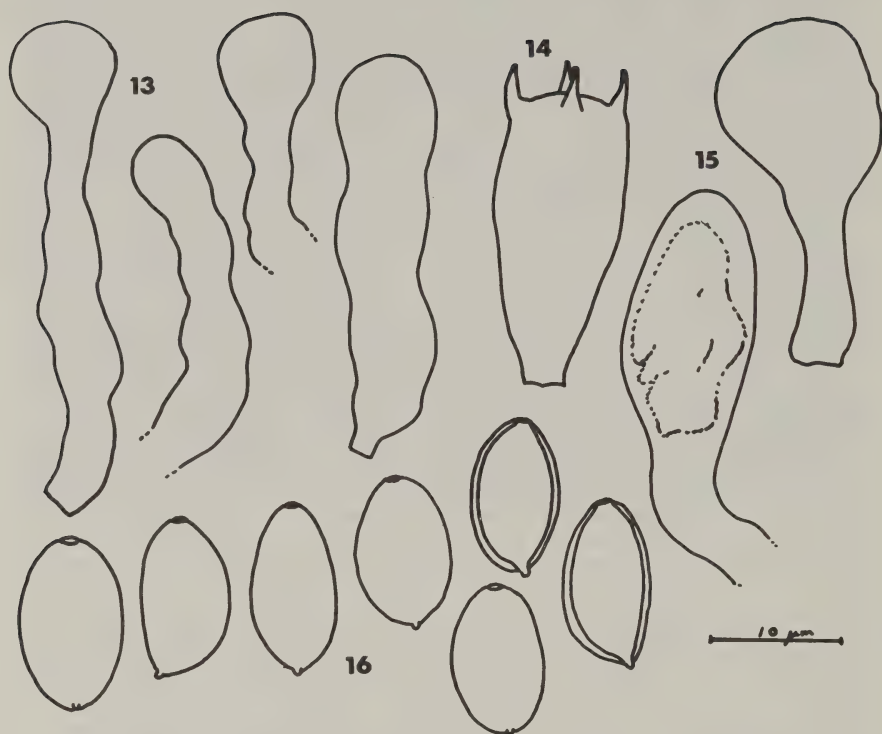
compost piles and the lack of earlier collections or observations are facts suggesting introduction.

Hypholoma (E. M. Fries) Kummer is adopted here, rather than the name *Naematoloma* P. Karsten, following the unanimous proposal of the Committee for Fungi and Lichens (Korf 1986). *Hypholoma tuberosum* is excluded from *Psilocybe* by the presence of chrysocystidia in the hymenium (Guzmán 1983). It is excluded from the genus *Stropharia* by the presence of a subcellular subpellis (Singer 1986) and by the lack of acanthocytes (see Farr 1980), although it does form unusual and often forked chlamydospore-like cells in the mycelium (Fig. 9).

Apparently sclerotia have not been reported in *Hypholoma* previously. Other Strophariaceae form sclerotia. Three species of *Psilocybe* are known to produce sclerotia, i.e. *P. caerulescens* Murr. (Guzmán 1978, 1983), *P. mexicana* Heim (Heim et al. 1958, Guzmán 1983, Stamets & Chilton 1983), and *P. tampanensis* Guzmán & Pollock (Guzmán 1983, Stamets & Chilton 1983). A fourth species, *Psilocybe tuberosa* Karst., associated with sclerotia, was redetermined to be a species of *Psathyrella* (Guzmán 1983). *Stropharia tuberosa* Beardslee (1918), described from North Carolina, forms sclerotia in old cow dung. Beardslee's herbarium was donated to Oberlin College following Beardslee's death (Burlingham 1948), and eventually was acquired by the University of Michigan (R. Shaffer, pers. comm.). A single specimen of *S. tuberosa* was among Beardslee's collections at Ann Arbor (MICH), with the following information: *Stropharia tuberosa* Beards. - on cow dung in woods, Asheville, N.C. The large tuber has been lost from this specimen but my photo shows it well. Like *S. umbonatescens* Pk. but differs in the tuber and much smaller spores which are 10-12 μ long in place of 18-20." Although no date is indicated, this material is considered to be authentic material, and possibly the only specimen in existence. It is here designated neotype. Material of this species could not be located in the herbaria at the University of Chapel Hill (NCU), Miami University (MU), the New York Botanical Garden (NY), or the U.S. Department of Agriculture, Beltsville (BPI) by the respective curators.

The following observations were made from the neotype: Pileipellis a well gelatinized layer approx. 100 μ m thick with embedded scattered filamentous, hyaline hyphae 2-3 μ m diam. Subpellis not well differentiated. Pileus trama composed of hyphae with some golden brown incrustations toward the pellis, up to 25 μ m diam. Cheilocystidia (Fig. 13) abundant and often clustered, hyaline, 30-37 x 5-7 μ m, mostly capitate to subcapitate, heads up to 8 μ m diam. Basidia (Fig. 14) short and clavate, 4-spored, up to 22 x 10 μ m. Pleurocystidia (Fig. 15) rare, scattered mostly towards the lamellar edge, not appreciably projecting, clavate, some possibly with a mucronate apex but in such poor condition this could not be clearly established, either golden yellow in ammonia sol. or chrysocystidium-like, with a discrete internal body. Basidiospores (Fig. 16) 11.5-13.5 x 6.5-8 μ m, purple brown, ellipsoid to slightly ovoid, smooth, with a thickened wall 0.5 μ m thick, with a well formed germ pore.

Stropharia tuberosa is probably a good species of *Stropharia*, although no acanthocytes were found at the base. Material with more abundant mycelium may yield these structures. The lack of a well differentiated subpellis, the more prominently gelatinized pileipellis



Figs. 13-16. *Stropharia tuberosa*, neotype. Fig. 13. Cheilocystidia. Fig. 14. Basidium. Fig. 15. Chrysocystidium-like pleurocystidia. Fig. 16. Basidiospores.

and viscid pileus when fresh, thicker spore walls, subcapitate to capitate cheilocystidia and scarcity of pleurocystidia all serve to distinguish *S. tuberosa* from *Hypholoma tuberosum*.

Another sclerotium-producing agaric, *Agrocybe arvalis* (Fr.) Singer, was found in one of the mulch beds studied (Univ. B.C. Botanical Gardens, Sept. 19 & 22, 1985, P.K. 873, 883, DAOM 198969, 198970; Sept 2, 1986, P.K. 1006, DAOM 196985). Macroscopically it differs from *H. tuberosum* by the lack of a partial veil, the snuff brown lamellae and spore deposit, and by the more regularly globose to ellipsoidal sclerotia, together with abundant white mycelial strands connecting the stipe and the sclerotia. Microscopically the apically digitate pleurocystidia of *A. arvalis* are distinctive (Watling 1982). The only previous reports of *A. arvalis* from North America we know of were by Lloyd (1917a, b), based on material sent from West Virginia. Gary Lincoff (pers. comm. to P.K.) has found material in the New York Botanical Gardens.

ACKNOWLEDGEMENTS

We thank Dr. R. Shaffer (MICH) for the loan of Beardslee's material of *Stropharia tuberosa*, Drs. J. Ammirati, Seattle, Wash., and Y. Dalpé, Ottawa, for reviewing the manuscript, and Regan Dixon for her assistance, keen observations, and for first bringing attention to *Hypholoma tuberosum*.

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ERRATA, VOLUME TWENTY-NINE

Page 467 line 13 for *xanthomelaenoides* read *xanthomelanoides*

NEW SPECIES AND NEW REPORTS IN THE PARMELIACEAE
(LICHENIZED ASCOMYCOTINA) FROM
SOUTH AFRICA AND AUSTRALIA

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ABSTRACT : Six species of Parmeliaceae: *Hypotrachyna colensoica* Hale, Nash & Elix, *Paraparmelia norlobaridonica* Nash & Elix, *Paraparmelia olivetorica* Nash & Elix, *Paraparmelia xanthomelaenoides* Elix & Nash, *Xanthoparmelia bicontinens* Elix & Nash, *Xanthoparmelia shebaisensis* Nash & Elix are described as new and 30 previously unreported species from South Africa are tabulated. *Paraparmelia xanthomelana* (Müll. Arg.) Hale is reduced to synonymy with *Xanthoparmelia adhaerens* (Nyl.) Hale.

Many new species of Parmeliaceae have recently been described from southern Africa (Brusse, 1984, 1985, 1986a, 1986b; Esslinger, 1977, 1986; Hale, 1965, 1971, 1976a, 1976b, 1976c, 1984, 1985a, 1985b, 1986; Knox & Brusse, 1983; Krog & Swinscow, 1979, 1981, 1983, 1986; Sérusiaux, 1983, 1984). Despite these reports recent field studies have indicated that a number of taxa remain to be described. In the present study six species are reported as new to science. Moreover we have noted a significant overlap with the Parmeliaceae of Australasia as shown by the number of new records reported below (14 out of 31 were previously only known from Australasia).

Throughout the present work chemical constituents were identified by thin layer chromatography (Culbertson 1972; Culbertson & Johnson 1982), high performance liquid chromatography (Lumbsch & Elix 1985) and comparison with authentic samples.

Hypotrachyna colensoica Hale, Nash & Elix sp.nov.

Fig.1

Thallus similis *Hypotrachyna lividica* (Taylor) Hale sed thallo viridi-flavo, saxicola atque acidum lividum continenti differt.

Type. Republic of South Africa. Transvaal Province. On sandstone cliffs, Mt. Sheba Nature Reserve, Pilgrims Rest, elev. 1965 m, grid 2430 DC, *M. E. Hale* 72203; US-holotype, PRE, ASU, ANUC-isotypes.

Thallus foliose, adnate to loosely adnate on sandstone, rather brittle, pale yellowish green, 5-8 cm in diameter; *lobes* short-sublinear, 0.5-1.5 mm wide, dichotomously branched, imbricate. *Upper surface* continuous, shiny, emaculate, black marginate near the apices, lacking soredia and isidia; medulla white; *lower surface* black except for a

narrow dark brown rim at the tips, plane, sparsely to moderately rhizinate, rhizines black, 0.5-1.0 mm long, rather coarse, sparsely dichotomously branched, often with splayed whitish tips. *Apothecia* numerous, adnate, 2-5 mm in diameter, disc flat to concave, deep brown, amphitheciium thin, continuous, smooth; hymenium 55-60 μ m high; spores (8), ellipsoid, 10-13 x 5-7 μ m.

Chemistry. Cortex K-; medulla K-, C-, KC-, P-; containing usnic acid, colensoic acid, 4-O-methylphysodic acid, lividic acid, physodic acid, 3-hydroxyphysodic acid.

Hypotrachyna colensoica is unusual in being the first reported fertile, nonsorediate, nonisidiate species with usnic acid endemic to the Old World. It is also unique in containing the lividic acid complex and usnic acid, a trait not known among the nine, lividic acid containing species of *Hypotrachyna* from the New World. Morphologically it is close to *H. livida*, a common corticolous lichen in southeastern U.S.A., southern Brazil and rarely Natal, but is somewhat smaller and saxicolous. It is known only from Mt. Sheba.

Specimens Examined (Paratypes)

REPUBLIC of SOUTH AFRICA. Transvaal Province. On sandstone rocks, Mt. Sheba, 24°56'S, 30°42'E, 1900m, T. H. Nash 23,401; ASU, ANUC, US.

***Paraparmelia norlobaridonica* Nash & Elix sp.nov.**

Fig.2

Species cum thallo ut in *Paraparmelia subspodochroa* sed ab hac specie norlobaridono continens differt.

Type. Republic of South Africa. Cape Province. On acidic rocks, Karoo Botanical Garden, 33°37'S, 19°22'30'E, 320m, T.H. Nash 23,482; ASU-holotype.

Thallus foliose, saxicolous, adnate, pale grey in colour but darkening with age, to 6 cm in diameter; lobes irregular to sublinear-elongate, (1.0)2.0-3.0 mm wide, irregularly branched, barely imbricate but contiguous. *Upper surface* opaque, emaculate, matt, the older lobes becoming cracked, lacking soredia and isidia; medulla white; *lower surface* black, often brown at the apices, moderately rhizinate, rhizines black, simple, slender. *Apothecia* common, adnate to substipitate, 1.0-3.0 mm in diameter, disc concave, dark brown, margin thin, continuous, amphitheciium smooth; spores (8), ellipsoid, 7-8 x 4-5 μ m.

Chemistry. Cortex K+ yellow; medulla K-, C-, KC+ rose, P-; containing atranorin, chloroatranorin, norlobaridone and an unknown.

This species is characterised by the black lower surface, the small foliose growth habit and the production of norlobaridone in the medulla. Morphologically *P. norlobaridonica* closely resembles *P. subspodochroa* Elix & Johnston as both species have similarly adnate thalli and lack soredia and isidia. However *P. norlobaridonica* is clearly distinguished by its medullary chemistry. *P. subspodochroa* by contrast contains salazinic acid, consalazinic acid and the constipatic acid ($\pm$) series in the medulla. At the present this species is known only from the type locality.

Specimen Examined (Paratype)

REPUBLIC of SOUTH AFRICA. Type locality, T.H. Nash 23,483 (ASU).

***Paraparmelia olivetorica* Nash & Elix sp.nov.**

Fig.3

Species cum thallo ut in *Paraparmelia pinguicida* sed ab hac specie colore subtus nigra, acido olivetorico et acido 4-O-demethylmicrophyllinico continens differt.

Type. Republic of South Africa. Cape Province. On acidic rocks, Bain's Kloof Pass, 33°35'S, 19°09'E, 600m, T. H. Nash 23,505; ASU-holotype.

Thallus small foliose to subcrustose, saxicolous, tightly adnate, pale grey in colour,

2-3 cm in diameter; *lobes* irregular to sublinear-elongate, 0.2-0.4 mm wide, irregularly branched, contiguous, becoming cracked and areolate in the older central portion of the thallus, areolae *ca.* 1.0 mm in diameter. *Upper surface* opaque, emaculate, shiny and black marginate near the apices, the older lobes becoming cracked and areolate, lacking soredia and isidia; medulla white; *lower surface* black, often brown at the apices, sparsely rhizinate, rhizines black, simple, slender. *Apothecia* not seen.

Chemistry. Cortex K+ yellow; medulla K-, C-, KC-, P-; containing atranorin, chloroatranorin (trace), olivetoric acid, 4-O-demethylmicrophyllidic acid, and traces of unknowns.

This distinctive species is characterised by the black lower surface, the small foliose to subcrustose growth habit and the production of medullary olivetoric acid and 4-O-demethylmicrophyllidic acid. Morphologically *P. olivetorica* closely resembles *P. pinguicida* Elix & Johnston as both species have similarly adnate thalli which become $\pm$ areolate centrally and lack soredia and isidia. However *P. olivetorica* is clearly distinguished by the black lower surface and its medullary chemistry. *P. pinguicida* by contrast has a tan to dark brown lower surface and contains the fatty acids: dehydroconstipatic, pertusaric, constipatic and protoconstipatic acids. At the present this species is known only from the type collection.

Paraparmelia xanthomelanoides Elix & Nash sp.nov.

Fig.4

Species cum thallo ut in *Paraparmelia mongaensis* sed ab hac specie acido stictico, acido constictico, acido norstictico ut acido cryptostictico continens differt.

Type. Republic of South Africa. Cape Province. On acidic rocks, Devil's Peak above the University of Capetown, 200m, *T. H. Nash* 23,581; ASU-holotype.

Thallus small foliose to subcrustose, saxicolous, tightly adnate, pale grey in colour, 3-5 cm in diameter; *lobes* irregular to sublinear-elongate, 0.2-1.0 mm wide, irregularly branched, contiguous, occasionally becoming cracked and areolate in the older central portion of the thallus, areolae *ca.* 1.0 mm in diameter or becoming lobulate. *Upper surface* opaque, emaculate, shiny and black marginate near the apices, the older lobes becoming cracked and areolate, lacking soredia and isidia; medulla white; *lower surface* black, often brown at the apices, moderately rhizinate, rhizines black, simple, slender. *Apothecia* common, adnate, up to 1 mm in diameter, spores (8), ellipsoid, 7-10 x 4-6 μ m.

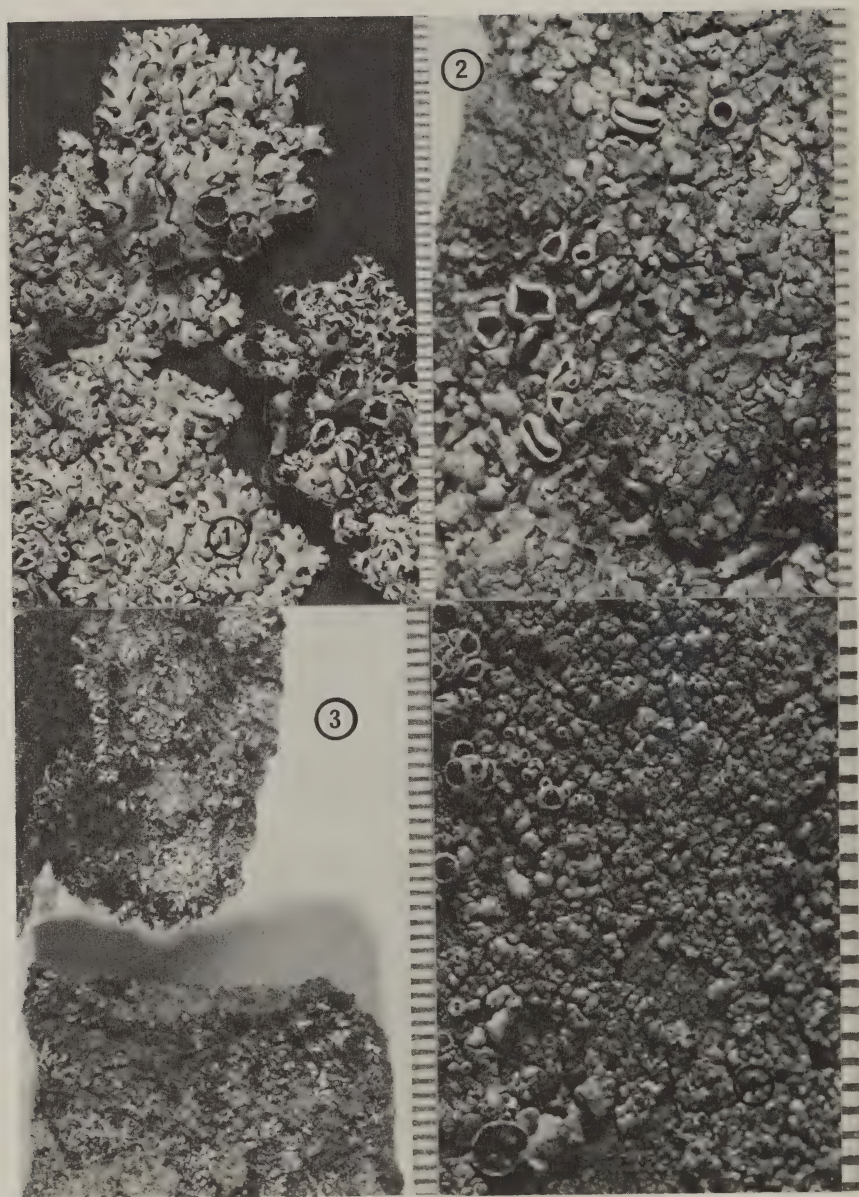
Chemistry. Cortex K+ yellow; medulla K+ yellow, C-, KC-, P+ orange; containing atranorin (trace), chloroatranorin, stictic acid (major), constictic acid, and traces of norstictic acid, cryptostictic acid and hypostictic acid ($\pm$).

This species was known formerly as *Paraparmelia xanthomelana* (Müll. Arg.) Elix & Johnston [syn. *Pseudoparmelia xanthomelana* (Müll. Arg.) Hale, *Parmelia xanthomelana* Müll. Arg.] but an examination of the lectotype specimen confirmed that this was synonymous with *Xanthoparmelia adhaerens* (Nyl.) Hale. This specimen [Sullivan 28, Grampian Mountains, Australia (G)] is somewhat discoloured due to long storage, but chemical examination by TLC and HPLC confirmed the occurrence of the stictic acid complex and **usnic acid**, but no traces of atranorin or chloroatranorin.

The new species, *Paraparmelia xanthomelanoides*, is well known and appears to quite widely dispersed in southern Africa.

Specimens Examined (Paratypes)

REPUBLIC OF SOUTH AFRICA: CAPE PROVINCE: Distr. Wynberg, Southern Cross Estate, *Almborn* 1549 (ANUC); Devil's Peak above the University of Capetown, 200m, *Nash* 23,580 (ANUC).



Figures 1-4. New species of Parmeliaceae. 1. *Hypotrachyna colensoica* Hale, Nash & Elix (Nash 23,401 in ASU); 2. *Paraparmelia norlobaridonica* Nash & Elix (holotype in ASU); 3. *Paraparmelia olivetorica* Nash & Elix (holotype in ASU); 4. *Paraparmelia xanthomelanoides* Elix & Nash (holotype in ASU); Scale in mm.

Xanthoparmelia bicontinens Elix & Nash sp.nov.

Fig.5

Species cum thallo ut in *Xanthoparmelia suberadicata* sed ab hac specie thallo arcte adnato differt.

Type. Australia. Victoria. On granite rocks in *Eucalyptus* forest with a *Lomatia*, *Telopea*, understory, Errinundra Flora Reserve, J.A.Elix 19949 & H.Streimann, 10.iv.1986; CBG-holotype, ASU-isotype.

Thallus foliose, saxicolous, adnate to tightly adnate, yellow-green in colour, 3-5cm in diameter; *lobes* linear-elongate, 0.5-1.0(-1.5)mm wide, dichotomously but sparingly branched, barely imbricate. *Upper surface* shiny, emaculate, apices often black marginate, lacking soredia and isidia; medulla white; *lower surface* jet black, shiny, wrinkled, moderately to sparsely rhizinate, rhizines black, simple, robust. *Apothecia* adnate, 1.0-2.0mm in diameter, the disc concave, red-brown to dark brown, margin thick, involute at first but thinner with age, amphithecium smooth; spores (8), ellipsoid, 7-8 x 4-5 μ m.

Chemistry. Cortex K-; medulla K+ yellow, C-, P+ orange; containing usnic acid, stictic acid (major), constictic acid (minor), norstictic acid (minor) and cryptostictic acid (trace).

This species is characterised by the tightly adnate thallus, linear-elongate, dichotomously divided lobes, a black lower surface and by the production of stictic acid and satellite compounds in the medulla. This combination of characters is also typical of *X. suberadicata* (des Abb.) Elix & Johnston but in the latter species the thallus is loosely adnate, the lobes moderately imbricate and often become suberect at the apices. By contrast *X. bicontinens* has an adnate to tightly adnate thallus with barely imbricate lobes which are appressed to the substrate throughout. This new species has also recently been recognised in collections from South Africa. In Australia it appears to be confined to rocks in the cool temperate rainforests of east Gippsland, Victoria.

Specimens Examined (Paratypes)

AUSTRALIA. VICTORIA: Type locality, Elix 19952 & Streimann (ANUC), Elix 19954 & Streimann (ASU, MEL).

REPUBLIC of SOUTH AFRICA: TRANSVAAL PROVINCE: immediately W of Graskop, 1490m, Nash 23,428 (ASU, ANUC).

Xanthoparmelia shebaiensis Nash & Elix sp.nov.

Fig.6

Species cum thallo ut in *Xanthoparmelia mannumensis* sed ab hac specie acido colensoico, acido norcolensoico et acido ignoto continens differt.

Type. Republic of South Africa. Transvaal Province. On sandstone rocks, Mount Sheba, 24°56'S, 30°42'E, 1900m, T.H.Nash 23,419; ASU-holotype.

Thallus small foliose, saxicolous, tightly adnate, yellow-green in colour, 3-4 cm in diameter; *lobes* linear-elongate, dichotomous, 0.2-0.7 mm wide, imbricate, becoming somewhat convolute. *Upper surface* opaque, prominently reticulately maculate, apices shiny and black marginate, lacking soredia and isidia; medulla white; *lower surface* black, brown at the apices, moderately rhizinate, rhizines black, simple, slender. *Apothecia* not seen.

Chemistry. Cortex K-, medulla K-, C-, KC-, P-; containing usnic acid, colensoic acid (minor), stenoporonic acid (major), and several unknowns.

This species is characterised by the black lower surface, the small foliose, imbricate growth habit and the production of colensoic acid and stenoporonic acid in the medulla. Morphologically *X. shebaiensis* closely resembles *X. mannumensis* (Elix) Elix & Johnston as both species have similar dichotomous lobes with distinctive maculae, lack soredia and isidia and have a black lower surface. However *X. shebaiensis* is clearly distinguished by the more adnate thallus and the occurrence of colensoic and stenoporonic acids. *X. mannumensis* by contrast contains diffractaic, barbatic, obtusatic, norobtusatic and 4-O-demethylbarbatic acids and has slightly broader, more loosely adnate lobes. At present this new species is known only from the type collection.



Figures 5-6. New species of Parmeliaceae. 5. *Xanthoparmelia bicontinens* Elix & Nash (holotype in CBG); 6. *Xanthoparmelia shebaiensis* Nash & Elix (holotype in ASU). Scale in mm.

ADDITIONS TO THE PARMELIACEAE FROM SOUTHERN AFRICA

Canoparmelia raunkiaeri (Vain.) Elix & Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1400-1650m, *Nash* 23,341 (ASU); along the Treur River near Clearwater Falls, 1200m, *Nash* 23,370 (ASU).

Canoparmelia zambiensis (Hale) Elix & Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: along the Treur River near Clearwater Falls, 1200m, *Nash* 23,371 (ASU).

Hypotrachyna bahiana (Nyl.) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near the top of the escarpment in the vicinity of Magoebaskloof, *Nash* 23,317 (ASU); Mac Mac Falls, 13 km from Sabie, *Nash* 23,446 (ASU).

Hypotrachyna formosana (Zahlbr.) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near the top of the escarpment in the vicinity of Magoebaskloof, *Nash* 23,319 (ASU); Mac Mac Falls, 13 km from Sabie, *Nash* 23,447 (ASU).

Hypotrachyna neodissecta (Hale) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near the top of the escarpment in the vicinity of Magoebaskloof, *Nash* 23,321 (ASU).

Hypotrachyna orientalis (Hale) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near the top of the escarpment in the vicinity of Magoebaskloof, *Nash* 23,322 (ASU); CAPE Province. Devil's Peak above the University of Capetown, *Nash* 23,557 (ASU).

Hypotrachyna scytophylla (Kurok.) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: Mount Sheba, 1900m, *Nash* 23,400 (ASU).

Paraparmelia mongaensis (Elix) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near top of the escarpment near Magoebaskloof, *Nash* 23,324 (ASU).

Paraparmelia owariensis (Asahina) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: immediately west of Graskop, 1490m, *Nash* 23,426 (ASU); Mac Mac Falls, 13 km from Sabie, *Nash* 23,451 (ASU).

Paraparmelia numinbahensis (Elix) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. CAPE Province: Karoo Botanical Garden, 320m, *Nash* 23,481 (ASU); Devil's Peak above the University of Capetown, 300m, *Nash* 23,579 (ASU, ANUC).

Paraparmelia spodochroma (Kurok. & Filson) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. CAPE Province: Bain's Kloof Pass, 600m, *Nash* 23,504 (ASU).

Parmotrema xanthinum (Müll. Arg.) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1650m, *Nash* 23,344 (ASU); along the Treur River near

Clearwater Falls, 1200m, *Nash* 23,377 (ASU); Mac Mac Falls area, 13 km from Sabie, *Nash* 23,449 (ASU).

Xanthoparmelia amplexula (Stirton) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1400-1650m, *Nash* 23,358 (ASU).

Xanthoparmelia austroamericana Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1400-1650m, *Nash* 23,360 (ASU); along the Treur River near Clearwater Falls, 1200m, *Nash* 23,381 (ASU); CAPE Province: Karoo Botanical Garden, 320m, *Nash* 23,485 (ASU), Devil's Peak above the University of Capetown, *Nash* 23,613 (ASU).

Xanthoparmelia crateriformis Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near top of escarpment in vicinity of Magoebaskloof, *Nash* 23,333 (ASU); Long Tom Pass between Sabie and Lydenburg, 2149m, *Nash* 23,437 (ASU).

Xanthoparmelia digitiformis (Elix & Armstrong) Filson

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1650m, *Nash* 23,533 (ASU); Mount Sheba, 1900m, *Nash* 23,538 (ASU).

Xanthoparmelia filsonii Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: near top of the escarpment in the vicinity of Magoebaskloof, *Nash* 23,334 (ASU).

Xanthoparmelia hypoprotocetrarica (Kurok. & Elix) Hale

REPUBLIC OF SOUTH AFRICA. CAPE Province: Bain's Kloof Pass, 600m, *Nash* 23,510 (ASU).

Xanthoparmelia incerta (Kurok. & Filson) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: Bain's Kloof Pass, 600m, *Nash* 23,526 (ASU); CAPE Province: Devil's Peak above the University of Capetown, *Nash* 23,622 (ASU).

Xanthoparmelia iniquita Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: Mount Sheba, 1900m, *Nash* 23,409 (ASU); CAPE Province: Skeleton Gorge above Kirstenbosch Botanical Garden, 250m, *Nash* 23,472 (ASU); Karoo Botanical Garden, 320m, *Nash* 23,489 (ASU); Bain's Kloof Pass, 600m, *Nash* 23,511 (ASU); Devil's Peak above the University of Capetown, ca 1000m, *Nash* 23,623 (ASU, ANUC, US).

Xanthoparmelia isidiigera (Müll. Arg.) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: Clearwater Falls, 1200m, *Nash* 23,536 (ASU); CAPE Province: Devil's Peak above the University of Capetown, *Nash* 23,625 (ASU).

Xanthoparmelia isidiosa (Müll. Arg.) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. CAPE Province: Devil's Peak above the University of Capetown, 200m, *Nash* 23,626 (ASU, ANUC, P, LD, US).

Xanthoparmelia neorimalis (Elix & Armstrong) Elix & Nash

REPUBLIC OF SOUTH AFRICA. CAPE Province: Karoo Botanical Garden, 320m, *Nash* 23,531 (ASU, ANUC, P, US).

Xanthoparmelia pertinax (Kurok. & Filson) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, *Nash* 23,363 (ASU); CAPE Province: Devil's Peak above the University of Capetown, 200m, *Nash* 23,628 (ASU, ANUC, US).

Xanthoparmelia pseudohypoleia (Elix) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. CAPE Province: Skeleton Gorge above Kirstenbosch Botanical Garden, 250m, *Nash* 23,473 (ASU).

Xanthoparmelia subramigera (Gyeln.) Hale

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1400-1650m, *Nash* 23,365B (ASU); along the Treur River near Clearwater Falls, 1200m, *Nash* 23,388 (ASU); Mount Sheba, 1900m, *Nash* 23,413; Long Tom Pass between Sabie and Lydenburg, 2149m, *Nash* 23,458 (ASU).

Xanthoparmelia tasmanica (J.D. Hook. & Tayl.) Hale

REPUBLIC OF SOUTH AFRICA. CAPE Province: Devil's Peak above the University of Capetown, 200m, *Nash* 23,633 (ASU); *ca.* 1000m, *Nash* 23,634 (ASU).

Xanthoparmelia tegeta Elix & Johnston

REPUBLIC OF SOUTH AFRICA. CAPE Province: Table Mountain, 1050m, *Nash* 23,476 (ASU); Bain's Kloof Pass, 600m, *Nash* 23,515 (ASU); Cape of Good Hope Nature Reserve, Olifants Baai, 40m, *Nash* 23,521 (ASU); Devil's Peak above the University of Capetown, *Nash* 23,635 (ASU, ANUC, P, US).

Xanthoparmelia terrestris (Kurok. & Filson) Elix & Johnston

REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: Long Tom Pass between Sabie and Lydenburg, 2149m, *Nash* 23,541 (ASU).

Xanthoparmelia verruciformis Elix & Johnston

NAMIBIA: Laguneberg Mountains adjacent Milepost 72, *ca.* 100m, *Nash* 23,301 (ASU); REPUBLIC OF SOUTH AFRICA. TRANSVAAL Province: western end of Soutpansberg Mountain, 1400-1650m, *Nash* 23,366 (ASU).

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STUDIES IN THE GENUS *PHOMA*. VIII.
CONCERNING *PHOMA MEDICAGINIS* VAR. *MEDICAGINIS*

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ABSTRACT

Phoma medicaginis Malbr. & Roum., the causal organism of black stem disease of alfalfa, is described and illustrated. Characteristics on agar media are documented, including the anatomy of its pycnidia. It is compared with *P. medicaginis* var. *pinodella* (L.K. Jones) Boerema. The latter is elevated to species rank, as *Phoma pinodella* (L.K. Jones) Morgan-Jones & Burch, because of significant and constant differences between it and *P. medicaginis*.

INTRODUCTION

Disagreement has existed in the literature over the identity of fungi implicated as causal agents of black stem diseases of forage legumes, including alfalfa (lucerne) [*Medicago sativa* L.] and red clover [*Trifolium pratense* L.], and particularly how many are involved (Boerema *et al.*, 1965; White and Morgan-Jones, 1987). Ellingboe and Kernkamp (1957), Ellingboe (1959a, 1959b), and Edmunds and Hanson (1957, 1960) considered the fungi causing black stem and early black stem disease, respectively, on these two hosts to be one species, while other authors (Johnson and Valteau, 1933; Schenck and Gerdemann, 1956; Boerema *et al.*, 1965; White and Morgan-Jones, 1987) have concluded that two distinguishable entities are involved which are sufficiently distinct to warrant recognition either as separate species or to be classified at varietal rank. The fungus on alfalfa has been given several names, of which *Ascochyta imperfecta* Peck and *Phoma herbarum* Westd. forma *medicaginum* Westd. (sometimes cited as *P. herbarum* Westd. var. *medicaginis* Fckl) appear most frequently in the literature. The current valid name for it is *Phoma medicaginis* Malbr. & Roum. var. *medicaginis* for the reasons explained by White and Morgan-Jones (1987).

Valteau and Fergus (1929) described a disease of alfalfa, sweet clover [*Melilotus indica* (L.) All.], and red clover in Kentucky, referring to it as "black stem" because of the characteristic presence of smooth black areas of various sizes on stems. They did not, however, determine the cause of the disease although they thought it to be of fungal origin. In the same year, Rosella (1929) reported a similar disease of alfalfa in France and named *Ascochyta medicaginis* Fckl as the cause. Horsfall (1930) reported red clover to be also damaged in New York by black stem disease. In Italy, Corneli (1932) described

a disease of alfalfa characterized by a necrotic zone at the base of leaf stalks causing leaves to become chlorotic. Although blackish, elongated spots were said to be present on stalks, Corneli considered the disease to be different from that described by Rosella, but attributed it to the same fungus, *Phyllosticta medicaginis* (Fckl) Sacc. [*A. medicaginis* Fckl]. The identification of the implicated fungus by Rosella and Corneli as *A. medicaginis* and *P. medicaginis*, respectively, was probably erroneous. *Ascochyta medicaginis* Fckl is a synonym of *Sporonema phacidioides* Desm. [teleomorph = *Leptotrochila medicaginis* (Fckl) Schüëpp (*Pyrenopeziza medicaginis* Fckl)], the type species of *Sporonema* Desm. (Sutton, 1980). This fungus, which occurs on leaves of a number of *Medicago* species, is an entirely different organism from that causing black stem and is not known to be in any way associated with the disease. Jones (1918) previously had recognized *A. medicaginis* and *P. medicaginis* to be synonyms of *S. phacidioides* and this to be the anamorph of *Pyrenopeziza medicaginis*, which he described as the causal organism of alfalfa yellow-leaf blotch.

Johnson and Valteau (1933), following detailed examination of a number of isolates from black lesions on alfalfa, and red and sweet clover stems, concluded that three different fungi were involved. Fresh isolates from alfalfa were said to differ in culture from those obtained from red and sweet clover. Colonies of the former were described as being, on PDA, white at first but soon becoming dark olive-gray, and producing pycnidia abundantly. Those from red and sweet clover were found to be white to faint pink, with irregularly concentric growth, before turning olive-gray. Old cultures from all three sources were generally similar in appearance, although isolates from red and sweet clover had more persistent white to gray aerial mycelium and fewer pycnidia. The colony surface of the alfalfa isolates appeared black and leathery due to abundance of pycnidia and chlamydospores. The authors were uncertain what name to apply to the alfalfa isolates and considered the following; *Phoma medicaginis* Malbr. & Roum., *Phoma herbarum* West., *Phoma vulgaris* Sacc., and *Phyllosticta medicaginis* (Fckl) Sacc. *Phoma herbarum* and *P. vulgaris* were discarded as choices because, in their words, they "can hardly be considered good species" on account of their being plurivorous! *Phyllosticta medicaginis* [wrongly assumed to be the same fungus as *Phoma medicaginis*] and *Phoma herbarum* f. *medicaginis* Fckl were said to be probably synonymous. Fuckel is not, incidentally, the correct authority for the latter name since he made only the combination *Pleospora medicaginis* Fckl [*Leptosphaeria medicaginis* (Fckl) Sacc.], a teleomorph, and adds: "Fungus pycnidium: *Phoma herbarum* Westend. Form. *medicaginis* in Rbh. F. eur. 455 b" (Fuckel, 1870). The authors fortuitously chose the name *Phoma medicaginis* over *Phyllosticta medicaginis* because the fungus was found on stems the year round. A new binomial, *Phoma trifolii* E.M. Johnson & Valteau, was proposed for the isolates derived from red clover, while those from sweet clover were determined to be *Ascochyta lethalis* Ell. & Barth. [teleomorph = *Mycosphaerella lethalis* Stone]. *Ascochyta lethalis* is listed by Melnik (1977), in the only modern treatment of the genus *Ascochyta* Lib., as a synonym of *A. viciae* Lib. PDA cultures of *A. lethalis* were described by Johnson and Valteau (1933) as being identical in appearance to those of *P. trifolii*, but larger, septate conidia produced by the former served to distinguish them. Pseudothecia of the *Mycosphaerella* teleomorph frequently were found among pycnidia on dead stems of sweet clover in the spring and single ascospore cultures produced the same anamorph as that isolated from black lesions. Stone (1912) had previously described *A. lethalis* and its teleomorph from *Melilotus alba* Desr. and *M. officinalis* (L.) Lam.

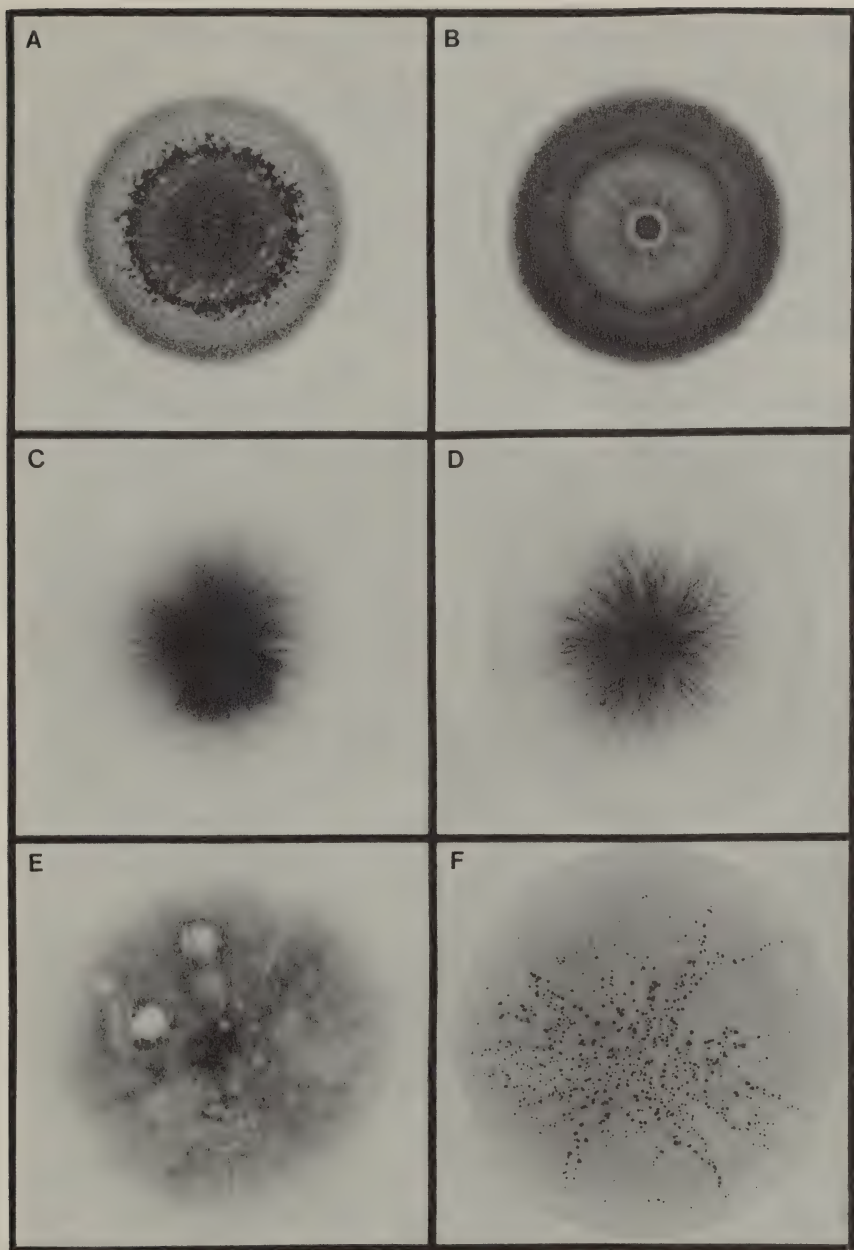


PLATE 1. *Phoma medicaginis*. A, 14-day old colony on PDA at 25°C; B, reverse of same; C, 14-day old colony on MEA at 25°C; D, reverse of same at 20°C; E, 28-day old colony on cellulose agar; F, reverse of same showing pycnidia.

[white and yellow sweet clover, respectively] in Kansas and New York.

Toovey *et al.* (1936), in a study of black stem disease of alfalfa in the United Kingdom, compared isolates from that country with a number obtained from the United States and provided a good account of the causal fungus. They chose, however, to use the binomial *Ascochyta imperfecta* Peck in preference to *Phoma medicaginis*, in part because they could not be certain of the correct application of the latter, since they had been unable to examine a type specimen. Colonies on PDA were described as being grayish to olive, becoming black to black olive with an irregular whitish margin. Abundantly produced pycnidia were said to be at first covered with an evanescent mycelial felt and then to become embedded in a carbonaceous matrix consisting of dark brown hyphae and chlamydospore-like bodies.

Schenck and Gerdemann (1956) compared a number of black stem-inducing isolates from alfalfa and red clover [for which the names *Phoma herbarum* var. *medicaginis* Westd. ex Rab. and *P. trifolii*, respectively, were used] originating in Illinois, Minnesota and Wisconsin. The pathogens were found to be similar, but constant differences occurred between them. Each fungus was most pathogenic on the host from which it was originally isolated. Cultural characteristics of *P. herbarum* var. *medicaginis* were stable, whereas *P. trifolii* was highly variable. Pycnidial production in *P. trifolii* was stimulated by light but this factor had no effect on *P. herbarum* var. *medicaginis*. Conidia of the latter germinated more rapidly than those of *P. herbarum* var. *medicaginis* and it had a faster growth rate. The authors concluded that it was undesirable to classify the two fungi as forms or varieties of the same species. They also noted that use of the name *Ascochyta imperfecta* for the alfalfa fungus could not be justified. Edmunds and Hanson (1957, 1960), although believing only one pathogen to be involved, documented differences between isolates derived from the respective hosts. Those obtained from alfalfa were again found to be less variable in culture and in pycnidial production than those derived from red clover. Although aware of the existence of the name *Phoma medicaginis* Malbr. & Roum. (which they listed as a later homonym of *Phoma medicaginis* Fckl), these authors continued to use *Ascochyta imperfecta* for isolates from both alfalfa and red clover. The name *Phoma medicaginis* Fckl, in common with *P. herbarum* f. *medicaginis* Fckl, as explained above, was never established.

Ellingboe and Kernkamp (1957) and Ellingboe (1959a, 1959b), as a result of a study of numerous monoconidial isolates from both alfalfa and red clover collected at widespread geographical locations in North America, concluded that no constant differences existed between them. Cultural characteristics, including variability and radial growth rates, as well as conidial production, septation and size, were considered. *Phoma herbarum* var. *medicaginis* Fckl was adopted, on the basis of date priority, as the valid name for the fungus and *P. trifolii* was considered a synonym.

Boerema *et al.* (1965), and White and Morgan-Jones (1987) have reviewed the considerable confusion, both taxonomic and nomenclatural, surrounding the fungi associated with black stem disease of legumes. Two entities are now thought to be involved, namely *Phoma medicaginis* var. *medicaginis* and *Phoma medicaginis* var. *pinodella* (of which *P. trifolii* is a synonym). The latter, which is known to be a pathogen of pea [*Pisum sativum* L.] as well as red clover and other members of the Fabaceae, has been previously described in this series of papers on *Phoma* Sacc. (White and Morgan-Jones, 1987). In the present paper

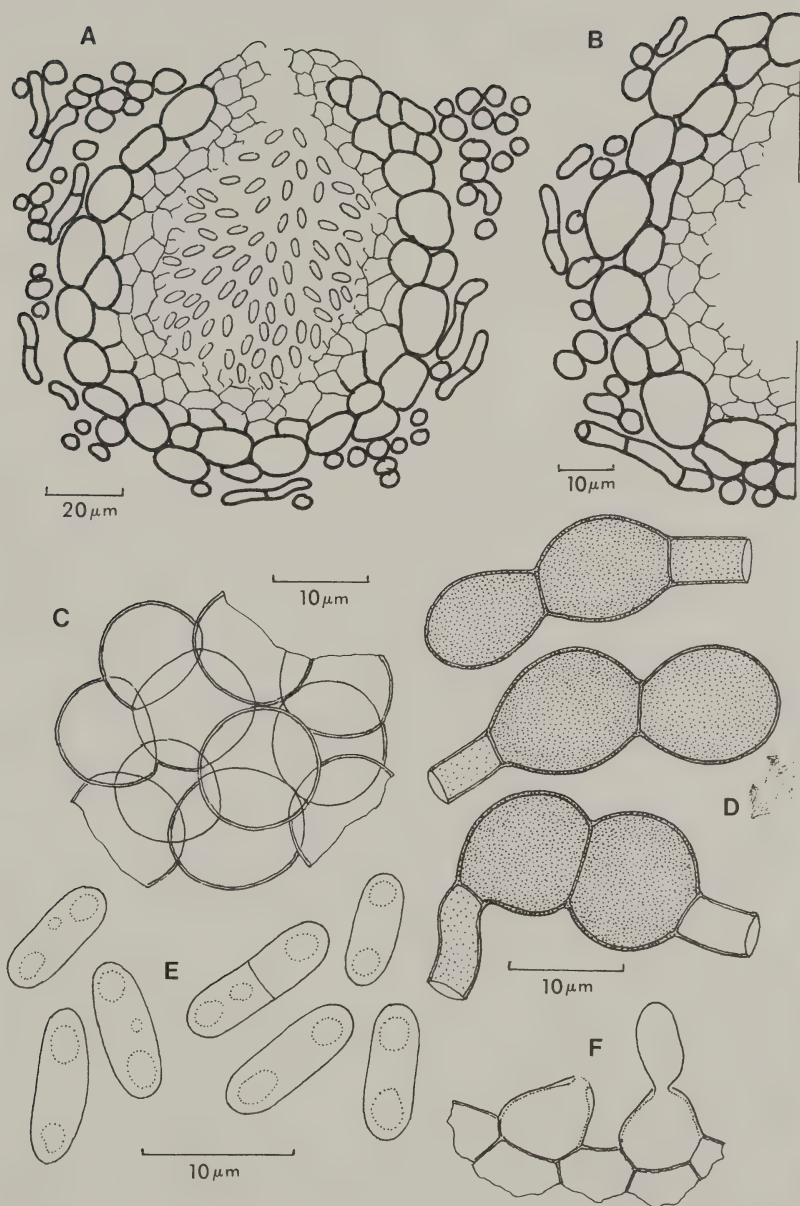


FIGURE 1. *Phoma medicaginis*. A, V.S. pycnidium; B, portion of pycnidial wall in section; C, outer pycnidial wall cells in squash mount; D, chlamydospores; E, conidia; F, conidiogenous cells.

a new, comprehensive description of *P. medicaginis* is offered and it is compared with *P. medicaginis* var. *pinodella*. The latter differs sufficiently from *P. medicaginis* to warrant classification as a separate species.

TAXONOMIC PART

Phoma medicaginis Malbr. & Roum., *Rev. Mycol.* 8: 91, 1886 (Plates 1 and 2, figure 1).

- = *Phoma herbarum* Westd. forma *medicaginum* Westd. apud Rabenh., *Fungi europ.* exs. n. ser. 2, no. 455b, 1862.
- = *Diplodina medicaginis* Oud., *Ned. Kruidk. Arch.* ser. 3, 2: 884, 1903.
- = *Ascochyta imperfecta* Peck, *Bull. N.Y. St. Mus.* 157: 21, 1912.
- = *Phoma cuscutae* Negru and Verona, *Mycopathol. Mycol. Appl.* 30: 308, 1966.

Colonies on potato dextrose agar [Difco] (Plate 1, A & B) generally uniform in appearance, occasionally sectoring (Plate 2, A & B), olive gray to dark olive gray, when young with a 3-4 mm wide whitish to pale buff margin, aerial mycelium in central portion progressively collapsing with age giving a darker coloration, sometimes concentrically zoned, eventually becoming totally carbonaceous black, attaining a diameter of 38 mm and 62 mm at 20C after 7 and 14 days, respectively, 39 mm and 75 mm at 25C, with little or no growth at 30C; reverse of young colonies uniformly olive black, in older colonies (Plate 1, B) darker towards the margin, often with one or more prominent, black, concentric rings. Colonies on PDA producing sectors usually remaining paler, except for localized radial portions where pycnidia occur. Colonies on malt extract agar [Difco] (Plate 1, C & D) with very sparse aerial mycelium, olive green, with a wide colorless marginal zone, immersed hyphae appearing black and distinctly dendritic in reverse view; occasionally, when old, producing small crystals in the medium, attaining a diameter of 30 mm and 70 mm at 20C after 7 and 14 days, respectively, 37 mm and 76 mm at 25C, with little or no growth at 30C. Colonies on cellulose agar [Eggins and Pugh, 1962; Morgan-Jones and White, 1983] (Plate 1, E & F) felty or somewhat lanose in patches, with a thin margin, pale olive gray, becoming mottled with variously sized, discrete tufts of whitish mycelium, attaining a diameter of 34 mm after 8 days at 20C and 45 mm at 25C; reverse colorless, except for irregular, more or less radial lines of scattered, blackish, partly-immersed pycnidia visible through the agar. Mycelium composed of hyphae of two types: hyaline, smooth, branched, septate, 2-3 μ m wide; and pale yellow brown, smooth, branched, 5-6 μ m wide. The latter hyphae are sometimes aggregated into strands, as in immersed mycelium when grown on MEA, and individual cells may become slightly inflated to 8 μ m wide with age. In older colonies on PDA, pycnidia are partly embedded in a thick matrix composed of interweaving, darker brown, thick-walled hyphae giving the colony surface a crusty, carbonaceous appearance. Pycnidia produced abundantly on PDA, gregarious, frequently confluent but maintaining discrete venters, more or less globose, superficial or partly immersed, without a well-defined ostiole, black at the base and sides, pale above, pseudoparenchymatous, 120-280 μ m in diameter. Pycnidial wall 20-30 μ m thick, made up of four to five layers of cells. Outer pigmented portion composed of two irregular layers of ellipsoid to subglobose, inflated, loosely organized, brown, thick-walled, 8-16 X 7-11 μ m cells. Inner portion composed of two or three layers of more or less isodiametric, angular, tightly arranged, hyaline, thin-walled, 4-6 μ m wide cells. Outer wall portion less distinguishable in the upper one-third of the pycnidium than elsewhere, the

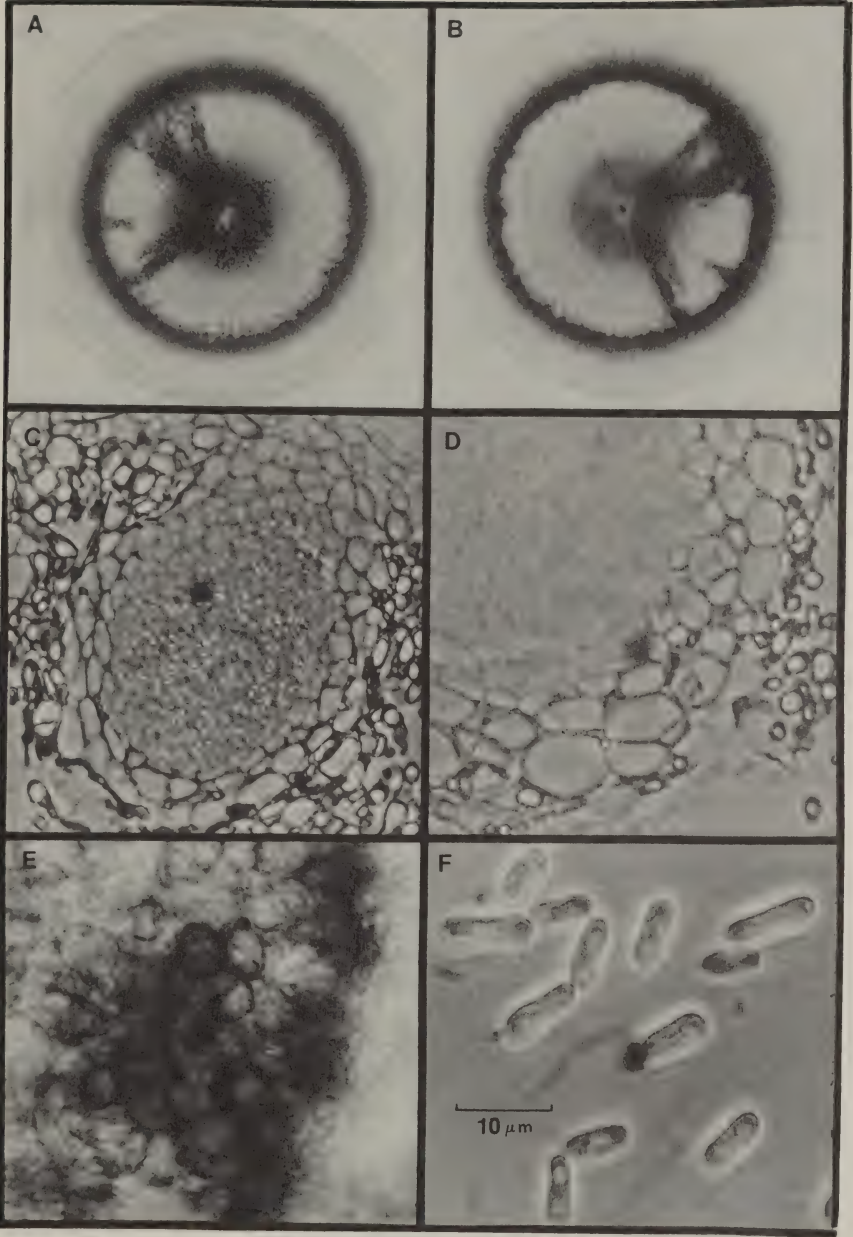


PLATE 2. *Phoma medicaginis*. A, 28-day old colony on PDA at 25C showing rare sectoring; B, reverse of same; C, V.S. pycnidium; D, portion of pycnidial wall in section; E, outer pycnidial wall cells in squash mount; F, conidia.

constituent cells being thin-walled and hyaline. Ostiole formed by irregular rupture of the thin-walled cells at the apex of the pycnidium. Conidiogenous cells phialidic, hyaline, simple, smooth-walled, ampulliform, borne from pycnidial wall cells lining the venter. Conidia enteroblastic, hyaline, smooth, oblong to short cylindrical, obtuse at each end, unicellular or occasionally becoming one-septate, especially with age, guttulate, 7-11 X 2-3.5 μ m. Conidial masses whitish to pale pink in color. Chlamydospores rarely produced in young cultures, commonly present in month-old colonies on PDA, mostly solitary, intercalary or terminal, subglobose to globose, smooth, thick-walled, brown, 7-14 μ m in diameter.

Mainly on genera of the Fabaceae; Europe and North America. Also reported from soil, as a contaminant of seeds, and on a variety of other hosts (Negru and Verona, 1966; Lakshmanan and Vanterpool, 1967; Sutton, 1980); probably cosmopolitan.

Collection examined: isolated from *Medicago sativa* L., The Netherlands, G.H. Boerema, PD66/703, CBS 533.66, ATCC 16929.

DISCUSSION

Although *Phoma herbarum* Westd. forma *medicaginum* Westd., has date priority over *P. medicaginis* Malbr. & Roum., it is unavailable for this fungus on two accounts. *Phoma herbarum* is an entirely different fungus and elevation of the varietal name *medicaginum* Westd. to species level in *Phoma* by making a new combination would create a later, illegitimate homonym of *P. medicaginis* Malbr. & Roum. The latter name becomes, as a result, the next available name for it. The varietal name *medicaginis* Fckl and *P. medicaginis* Fckl, as already noted, were invalidly concocted by other authors. The name *Ascochyta pisi* Lib. var. *medicaginis* Sacc., which Sprague (1929) and Toovey *et al.* (1936) considered to be the same as *Ascochyta imperfecta*, and which was included by Edmunds and Hanson (1960) in the synonymy of their *Phoma medicaginis* Fckl, represents a different species (Boerema *et al.*, 1965).

Rössner (1968) recognized within *Phoma medicaginis* var. *medicaginis* two groups based on the presence or absence of septate conidia and differences in conidial size, namely: forma *macrospora* and forma *microspora*. Boerema (1976) noted these to be invalid names according to Article 36 of the International Code of Botanical Nomenclature. Conidial size and septation in *P. medicaginis* appear to be highly variable. In our experience, septa are more commonly found in older cultures. In most isolates, even when grown under various cultural conditions, generally no more than half of the conidia are bicellular and often far fewer (Schenck and Gerdemann, 1956; Ellingboe, 1959a). Ellingboe (1959a) reported that only two out of sixty-two monoconidial isolates grown on PDA, had more than 50% of their conidia producing septa. Among one hundred twelve monoconidial isolates taken from one culture of *P. medicaginis* which produced 6% bicellular conidia, septation ranged from 0 to 6%. One monoconidial isolate with 2% bicellular conidia yielded some subisolates that produced only unicellular conidia, while others had 50% of their conidia bearing septa. The culture medium was said to have had a decided effect on whether or not septa were produced. Substantial differences in percent conidial septation were found by Schenck and Gerdemann (1956) when seventeen isolates were grown on PDA and autoclaved alfalfa stems. Conidia from the former were found to be more frequently septate as compared to the latter, where they

were predominantly unicellular. Edmunds and Hansen (1960) observed that, in nature, conidia are mostly continuous whereas, when brought into culture, septation is often more abundant.

When Boerema (in Boerema *et al.*, 1965) transferred *Ascochyta pinodella* L.K. Jones into *P. medicaginis* as an infraspecific taxon at varietal rank and thereby established the trinomial *P. medicaginis* var. *pinodella* (L.K. Jones) Boerema, var. *medicaginis* was automatically created without citation of an author's name according to Article 26 of the Code. The rank of variety is commonly accorded in mycology to populations of a species differing consistently in some characteristic (Hawksworth, 1974). As an example in *Phoma*, *P. macrostoma* Mont., var. *incolorata* (Horne) Dorenbosch & Boerema differs from var. *macrostoma* by absence of red pigment in its hyphae. Although having close affinity, we believe *P. medicaginis* var. *pinodella* to differ from var. *medicaginis* to a greater extent than is reflected by its classification at varietal rank. The following nomenclatural transfer is therefore made: *Phoma pinodella* (L.K. Jones) comb. nov. [basonym: *Ascochyta pinodella* L.K. Jones, *Bull. N.Y. St. Agric. Exp. St.* 547: 10, 1927]. With this action, var. *medicaginis* becomes redundant.

Some of the main differences between *P. medicaginis* and *P. pinodella* have been documented previously (White and Morgan-Jones, 1987). In culture, the former grows more slowly and colonies are less variable in appearance. Sectoring is common in *P. pinodella* but rare in *P. medicaginis* and older colonies of the latter on PDA have a distinct, uniform carbonaceous aspect. Colonies of *P. pinodella* on MEA produce abundant feather-like, dendroid, whitish crystals in the medium, and numerous chlamydospores are present even when very young. In *P. medicaginis*, a few, scattered crystals occasionally occur in cultures over a month old on MEA and chlamydospores are produced only in older cultures on all media. The conidia of both species are essentially similar, except that some produced by *P. medicaginis* slightly exceed in length the largest of those of *P. pinodella*. That these two taxa are distinct entities is best reflected in the anatomy of their pycnidia. The pycnidial wall of *P. medicaginis* is appreciably narrower than that of *P. pinodella* and the relative shape and size of external wall cells differ. Those of *P. medicaginis* are broadly ellipsoid to subglobose (Plate 2, D & E), generally more loosely organized, and abut the matrix of thick-walled hyphae surrounding the pycnidia. Chlamydospores, or slightly swollen hyphal elements present in the matrix, in older cultures on PDA, often adjoin the outer pycnidial wall cells. Boerema *et al.*, (1965) recognized a difference in the pycnidial wall structure between *P. medicaginis* and *P. pinodella*. They referred to the wall of the former as being "textura globulosa" sensu Starbäck (1895), while the latter was described as intermediate between this and "textura prismatica". The secondary pycnidia, known to be produced by *P. pinodella*, are absent in *P. medicaginis*. In addition to morphological distinctions between the two taxa, there are also differences in their pathogenicity as related to hosts. The association in nature between *P. medicaginis* and black stem disease of alfalfa is constant as is that of *P. pinodella* and black stem disease of red clover and footrot of pea. Although individual isolates from one host are able to attack other legume species, they are invariably more pathogenic on their original hosts (Boerema *et al.*, 1965).

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ENDOPHYTE-HOST ASSOCIATIONS IN FORAGE GRASSES. IX. CONCERNING *ACREMONIUM TYPHINUM*, THE ANAMORPH OF *EPICHLÖE TYPHINA*

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ABSTRACT

Acremonium typhinum Morgan-Jones and W. Gams, the anamorph of *Epichloe typhina* (Fr.) Tulasne, is described and illustrated *in vivo* on host grasses, from collections made on *Agrostis hiemalis* (Walt.) B.S.P. and *Elymus canadensis* L. in Texas. Cultural characteristics *in vitro* of isolates of the fungus made from leaf sheaths, stems, seeds and stromata are also documented. Comments are offered on the nomenclature and taxonomy of anamorphic fungal endophytes of forage grasses classified in *Acremonium* Link, section *Albo-lanosa* Morgan-Jones and W. Gams.

INTRODUCTION

Epichloe typhina (Pers.) Tul., the causal organism of choke disease of grasses, first recorded [as *Sphaeria typhina* Pers.] by C.H. Persoon in 1789, is a species of cosmopolitan distribution, but with a host range confined predominantly to the Poaceae (Kilpatrick *et al.*, 1961). Bail (1861) described the fungus as an epiphyte living on the surface of leaf sheaths but de Bary (1863) established a connection between mycelium in the host plant and reproductive ectostromata. The latter author noted the presence of slender, septate, sparsely branched hyphae in stems immediately below stromata and determined that conidia, and later perithecia, develop from these. The truly endophytic habit of the fungus was documented in a detailed study by Sampson (1933) who showed it to be present intercellularly within tissues of leaves, stems and seeds of a number of grasses including *Dactylis glomerata* L., *Festuca rubra* L., and

*Parts I-VI of this series appeared in *Mycologia*, part VII in *Mycotaxon*, and part VIII in the *American Journal of Botany*.

Holcus mollis L. Petch (1937), in a brief description, noted that the fungus produces a stroma sheathing stems of grasses which is at first white and bearing conidia on *Cephalosporium* conidiophores. There is no visible damage to vegetative shoot apices and the fungus grows vigorously only in response to the production of young inflorescences (Kirby, 1961). The endophyte egresses from its host during elongation of the culm, at which time the inflorescence, and usually some of the surrounding leaves, are enveloped with mycelium which eventually becomes organized into an ectostroma. Sampson and Western (1954) and Western and Cavett (1959) described the disease syndrome induced by the fungus and also made note of the fact that conidia are produced from young stromata. They did not, however, give an account of the morphology of the anamorph.

Saccardo (1881) described what was assumed to be the conidial state of *E. typhina* and applied the name *Sphacelia typhina* Sacc. [as "(Pers.) Sacc"] to it. This binomial has, over the years, been the name commonly cited (for example, Petch, 1937; de Hoog, 1977; Subramanian, 1979; von Arx, 1981; Tubaki, 1981) although some authors who studied *E. typhina* chose not to use any name for the anamorph (for example, Sampson and Western, 1954; Western and Cavett, 1959; Kohlmeyer and Kohlmeyer, 1974). As indicated in a previous publication (Morgan-Jones and Gams, 1982) one cannot determine, on the basis of his description and examination of specimens extant in his herbarium, that Saccardo ever observed the true anamorph of *E. typhina*. *Sphacelia typhina* must therefore be regarded as a *nomen dubium* because it is a name of uncertain application since it cannot be satisfactorily typed. In view of this, Morgan-Jones and Gams (1982) established the name *Acremonium typhinum* Morgan-Jones and W. Gams for the anamorph.

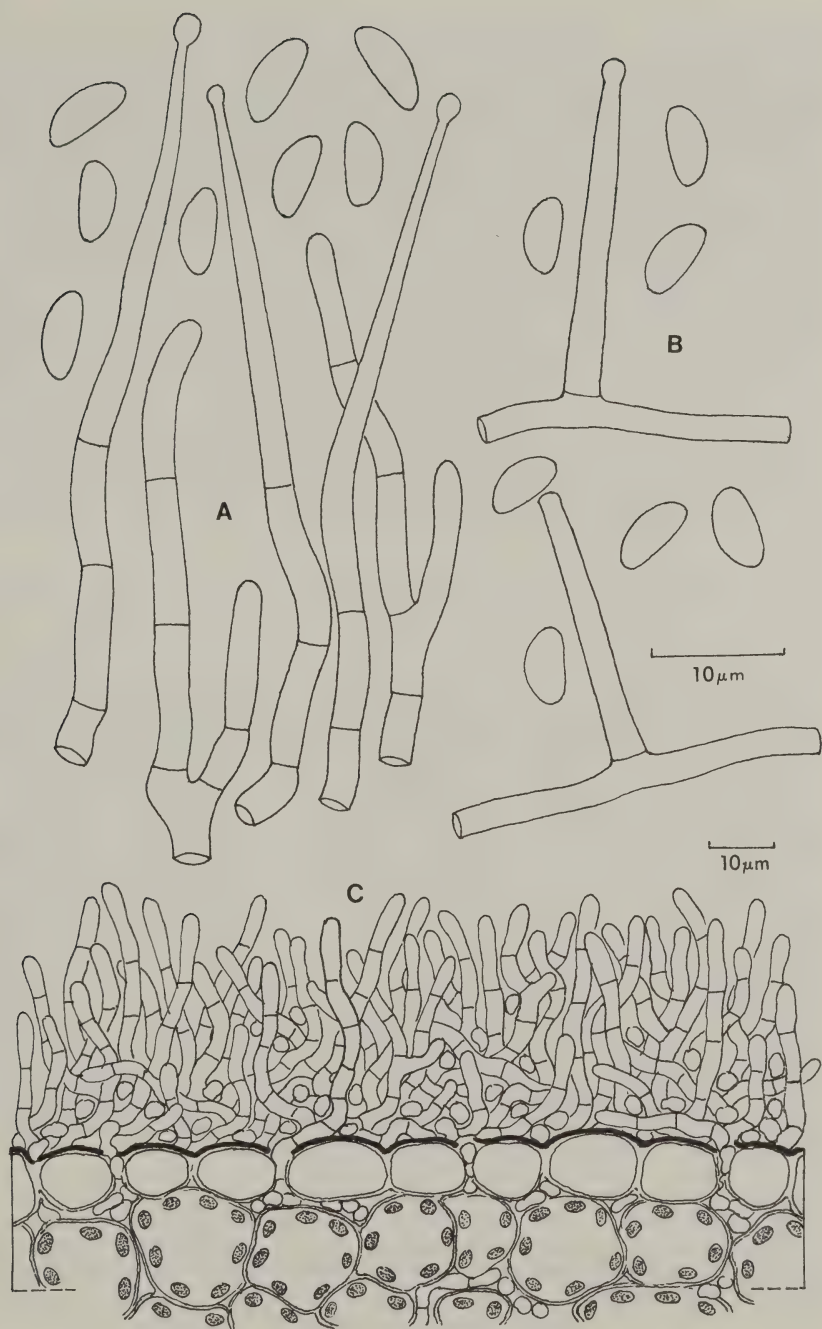
Morgan-Jones and Gams (1982) and Latch *et al.* (1984) described the anamorph *in vitro* and the latter authors provided a brief account of its morphological expression *in vivo* on *Festuca rubra* in New Zealand. Latch *et al.* (1984) continued to use the name *Sphacelia typhina* Sacc. since they considered the anamorphs of *Epichloe typhina* and *Claviceps purpurea* (Fr.) Tul. [anamorph = *Sphacelia segetum* Lév., the type species of *Sphacelia* Lév.] to have the same basic morphology and therefore to be congeneric.

We have had opportunity this past year to examine *Acremonium typhinum* *in vivo* on *Agrostis hiemalis* (Ticklegrass) and *Elymus canadensis* (Canada wildrye) in Texas and to again isolate the fungus in pure culture. This enables us to offer a fully comprehensive description of the fungus for the first time and to discuss problems relating to its taxonomy and nomenclature.

MATERIALS AND METHODS

Conidial stromata of *Acremonium typhinum* were collected from populations of *Agrostis hiemalis* (W.) B.S.P. in Brazoria Co., and from populations of *Elymus canadensis* L. in Travis Co. and Caldwell Co., Texas. For histological studies, they were cut into pieces approximately 2 mm in diam-

FIGURE 1. *Acremonium typhinum*. A, conidiogenous cells, conidia and sterile stromal hyphae from *E. canadensis*; B, conidiogenous cells and conidia from culture on PDA; C, transverse section of young conidial ectostroma on *E. canadensis*.



eter and fixed in FAA (5 parts stock formalin, 5 parts glacial acetic acid, 90 parts 50% ethanol). The tissue was then washed, dehydrated in a graded ethanol series and embedded in plastic (LR White® medium). Sections approximately 0.5-1 µm were cut with glass knives using a Sorvall® MT-2 ultramicrotome and stained with methylene-blue (1% aqueous) for 30 seconds at room temperature. Additionally, mycelium and conidia were scraped from stromata and placed in a drop of aniline-blue (0.2% aqueous). Slides were examined under a light microscope. The fungus was isolated from leaf sheaths, stems, and stromata from representative plants in all populations by the methods of Clark *et al.* (1983). For growth studies, cultures were initiated on potato dextrose agar [PDA (Difco)] using 2 mm-square pieces of mycelium cut from the margins of 30-day-old colonies growing on the same agar. Four plates were each incubated for 14 days in continuous darkness at 23, 25, and 28C, respectively. Representative specimens and dried cultures have been deposited in the mycological herbarium at Auburn University (AUA).

TAXONOMIC PART

Acremonium typhinum Morgan-Jones and W. Gams, Mycotaxon 15: 313, 1982 (Figures 1 & 2, Plates 1 & 2).

[Teleomorph *Epichloe typhina* (Pers.) Tul.]

Mycelium in grass hosts intercellular, generally systemic, composed of septate, smooth, hyaline, sparsely branched, 1-2 µm wide hyphae. Conidial ectostroma (Plate 1, A) enveloping and girdling flag leaf and culm, white, 3-10 cm long on *E. canadensis*, showing some variability among populations, usually somewhat shorter on *A. hiemalis*, 50-160 µm thick, initiated by emergence of hyphae between dislodged epidermal cells, at first loosely organized and composed of branched, interweaving, abundantly septate, 2-3 µm wide hyphae, then becoming, through continued growth and cell division, progressively compacted and assuming a prosenchymatous texture, inner limits proximal to leaf surface eventually assuming a somewhat pseudoparenchymatous appearance with the cells often inflated, hyphae in middle portion orientated horizontally or, more predominantly, slightly ascending, those in a broad outer zone arranged perpendicular to the leaf and stromal surfaces (Figure 2). At time of conidial stroma maturity, mycelium frequently present intracellularly in leaf mesophyll cells. Conidiophores caespitose, arranged in a compact layer over the whole exposed surface of the stroma, unbranched or branched, cylindrical, septate, interspersed at any given time, especially shortly after initiation of conidiogenesis, with sterile hyphae of shorter or approximately the same length; such hyphae, whose free tips are often slightly curved (Plate 2, A), sometimes arising as lateral branches of conidiophores and functioning essentially as packing elements in the manner of paraphyses and cystidia although some, if not all, may eventually become fertile, making possible the production of a succession of conidiogenous cells. Conidiogenous cells (Figure 1, A; Plate 2, C & D) holoblastic, terminal, determinate, attenuating gradually, with a long, narrow, aculeate distal portion, straight or slightly flexuous, thin-walled, hyaline, 15-30 µm in length, 1.7-2.5 µm wide at base, 0.5-1 µm at extreme apex, the tip appearing closed and lacking any periclinal thickening. Conidia (Plate 2, E & F) navicular, flattened in one plane to give the shape of a citrus fruit segment viewed sideways, dry, unicellular, smooth, hyaline, thin-walled, 4-6 X 2-3 µm, produced in abundance, and accumulating in clusters, giving the stromal surface a farinaceous appearance.

443	47	for	"L. intumes-		
444	55	for	personii	read	"Lecidea intumes-
445	8	for	nootkatenis (terrier)	read	persoonii
492	23	for	<i>E. canadensis</i>	read	nootkatenis (Terrier)
	24	for	<i>A. hiemalis</i>	read	<i>Elymus canadensis</i>
494	24	for	<i>E. typhina</i>	read	<i>Agrostis hiemalis</i>
					<i>Epichloe typhina</i>

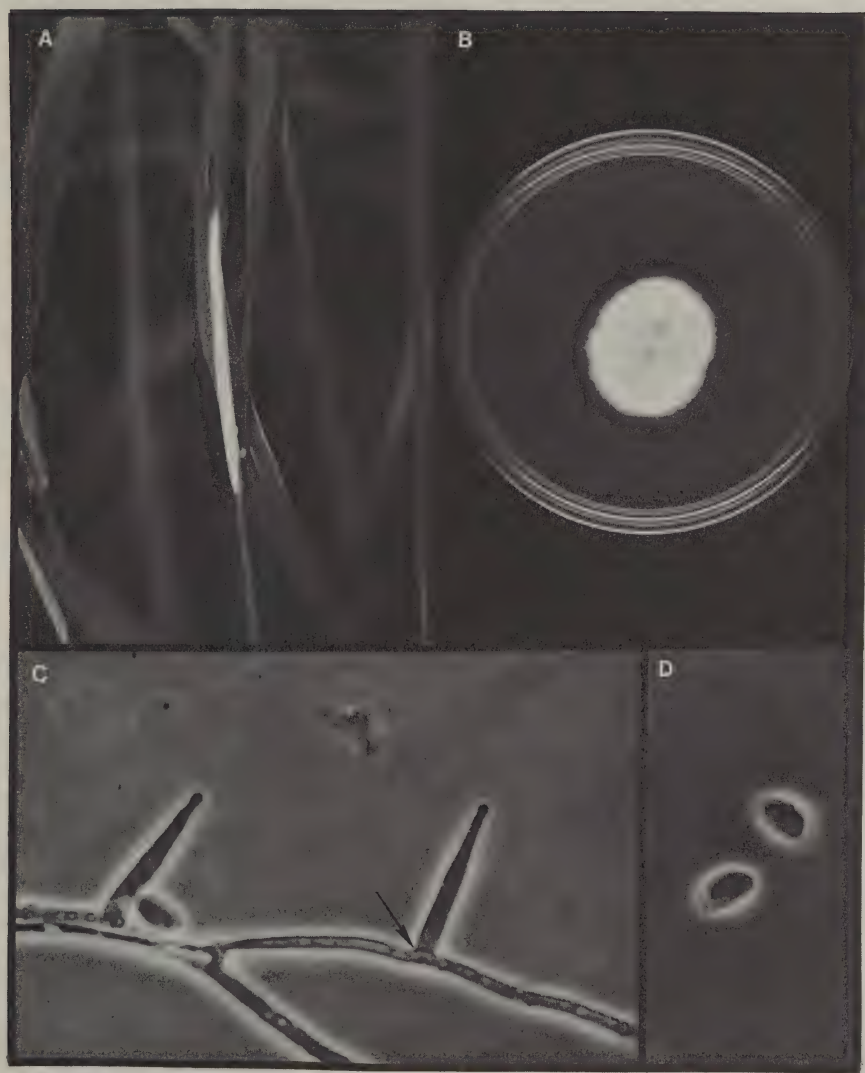


PLATE 1. A, White conidial ectostroma of the *Acremonium* anamorph of *Epichloe typhina* on culm of *Elymus canadensis*; B, *Acremonium typhinum*, 20-day-old colony on PDA; C, conidiogenous cells and conidial initials (basal septum indicated by arrow) [X 1800]; D, conidia [X 2300].

Colonies on PDA (Plate 1, B) white, cottony to felty, with an even or very slightly arachnoid margin, slow-growing, attaining a diameter of 15 mm after 14 days at 22C, 17 mm at 25C, and 8 mm at 28C. Colony reverse pale brown centrally, lighter towards the margin. Vegetative hyphae hyaline, smooth, 1.5-2 μ m wide. Conidiogenous cells (Plate 1, C) sparsely produced, arising solitarily from aerial hyphae, discrete, lateral, orthotropic, more or less cylindrical over the lower two-thirds, gradually attenuating distally, hyaline, smooth, each one usually delimited by a basal transverse septum located close to the junction with parent hypha (Plate 1, C; indicated by arrow), 12-20 μ m long, 1.5-2 μ m wide at base, 0.5-1 μ m wide at the tip, although having the aspect of a phialide lacking any periclinal thickening towards the apex, bearing a conidium which, when fully formed, frequently lies transversely over the tip or with the tip appearing closed. Conidia (Plate 1, D) similar to those produced *in vivo* on grass hosts, but slightly smaller, 3-5 X 1.5-3 μ m, and more obtuse at each end.

Collections examined: On *Agrostis hiemalis*, Angleton, Brazoria County, Texas, May 15, 1986, J.F. White, Jr., AUA; on *Elymus canadensis*, Austin, Travis County, Texas, April 1, 1986, J.F. White, Jr., AUA; Caldwell, Burleson County, Texas, May 1, 1986, J.F. White, Jr., AUA.

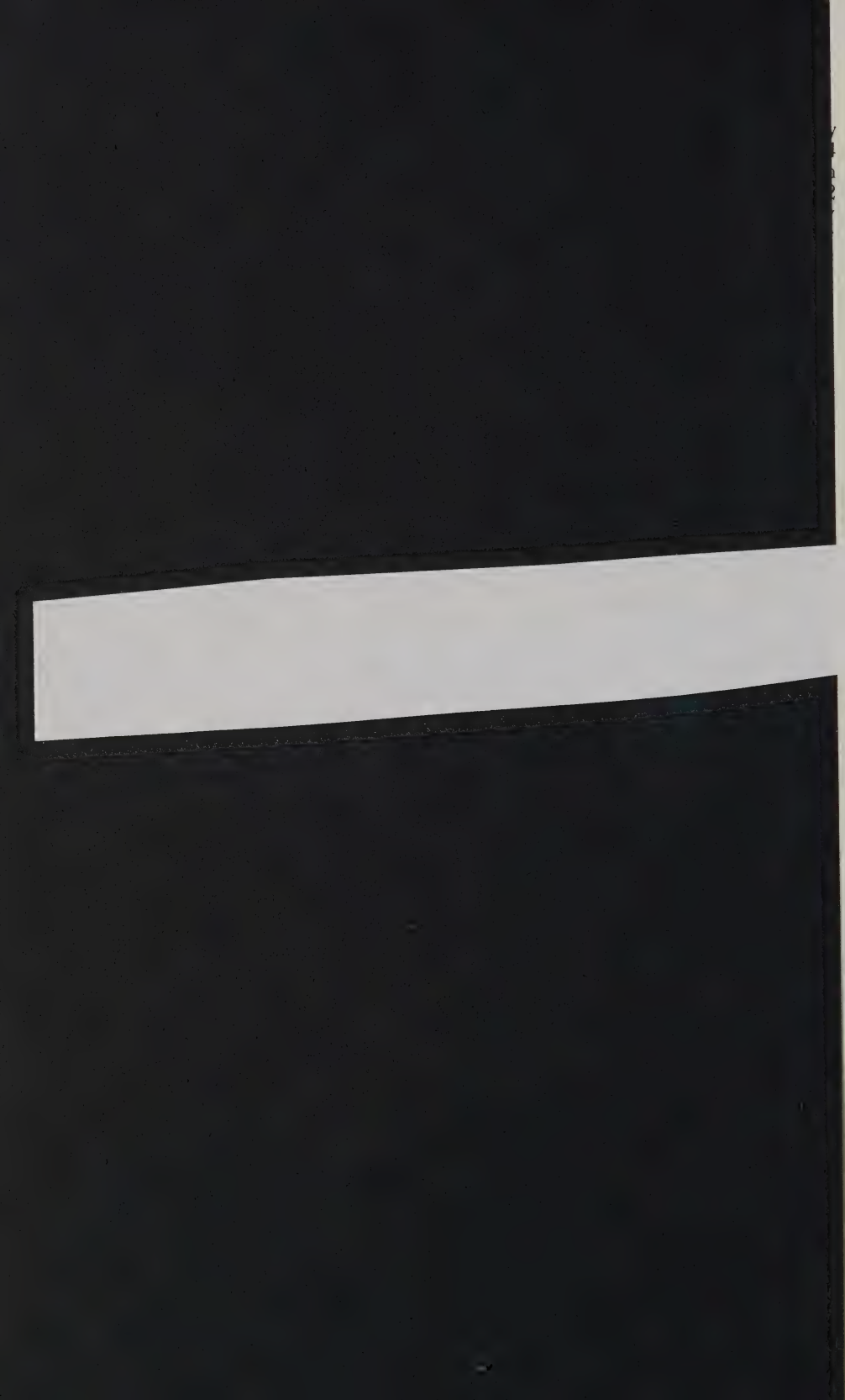
DISCUSSION

There appear to be differences in stromal size depending on host grass and, perhaps, climatic factors. Latch *et al* (1984) reported stromata on culms of *Festuca rubra* in New Zealand to measure 1.5-3 cm long, considerably shorter than those described above. Sampson (1933) noted plants of *F. rubra*, known to be colonized by *E. typhina*, to produce conidial stromata unpredictably from season to season and perithecial production to be relatively rare on this host. In Texas, perithecia were found to occur abundantly on both *A. hiemalis* and *E. canadensis* following conidiation.

Conidia produced *in vivo* on host grasses and *in vitro* on agar media are more or less identical except for a small size difference and the fact that the former are more pointed at each end. Conidiogenous cell morphology, however, differs significantly in the two circumstances. Conidiogenous cells produced from stromata on host grasses are generally much longer, although there may be some overlap in measurements, and more attenuated than those produced in culture. In both situations they are, however, essentially *Acremonium*-like. Morgan-Jones and Gams (1982) found conidiogenous cells of three isolates [from *Dactylis glomerata*, *Holcus mollis* L. (type of *Acremonium typhinum*), and *Sphenopholis obtusata* (Michx.) Scribn.] to be consistently delimited from their subtending parent hyphae by a basal septum, as is the case in those described above. Latch *et al.* (1984), however, stated that conidiogenous cells in their isolates from *F. rubra* lacked a basal septum, a condition characteristic of *A. coenophialum* Morgan-Jones and W. Gams.

As with other anamorph taxa in this complex (cf. White and Morgan-Jones, 1987), it is difficult to determine, within the resolution limits of the light microscope, details of cell wall relationships between conidiogenous cells and conidia during conidiogenesis in *A. typhinum*. Although we refer to the conidiogenous cells as being holoblastic, we are by no means certain of the precise way in which conidia are elaborated. There is no flaring of the apex of the conidiogenous cells and no apparent periclinal thickening typical of most

	24	for	<i>A. hiemalis</i>	read	<i>Elymus canadensis</i>
494	24	for	<i>E. typhina</i>	read	<i>Agrostis hiemalis</i>
	26	for	<i>E.</i>	read	<i>Epichloe typhina</i>
496	19	for	<i>A. typhinum</i>	read	<i>Elymus</i>
				read	<i>Acremonium typhinum</i>



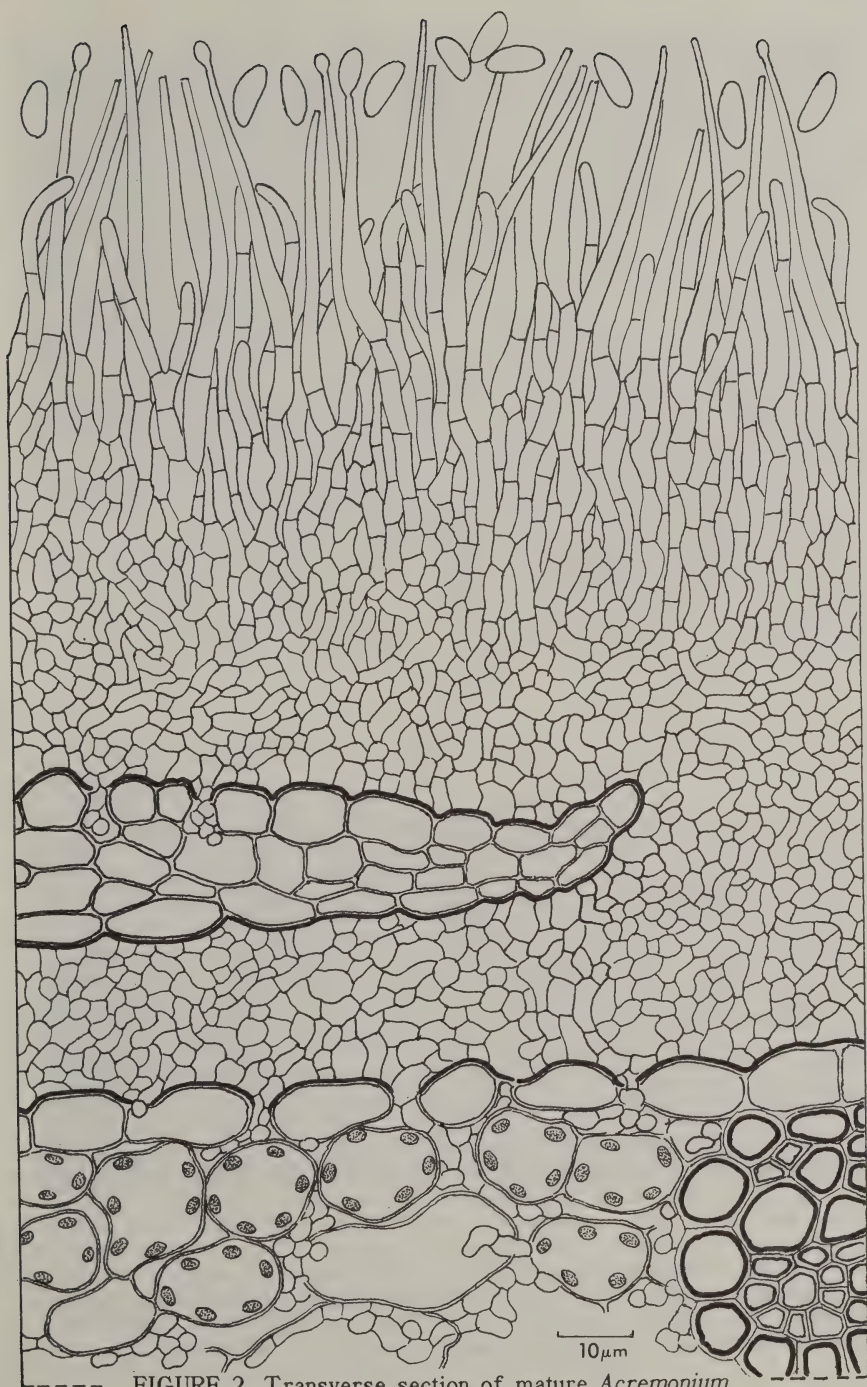


FIGURE 2. Transverse section of mature *Acremonium typhinum* conidial ectostroma on *Elymus canadensis*.

phialides. In addition, their extreme tip invariably appears closed. Conidia are produced singly in culture, but we have not been able to determine with certainty how many conidia are produced per conidiogenous cell in nature. Clusters of conidia are often found elevated above the stromal surface supported by a number of conidiogenous cells. Assumption of this position may aid dispersal by insects. A mature conidial stroma is normally covered with dense masses of conidia. In the material on grasses studied by us, we have found that at any one time, even in seemingly mature stromata, sterile hyphal elements can be found intermixed with conidiogenous cells making up the exposed hymenium. A majority of the hyphal elements may ultimately become fertile, which probably accounts for the abundance of conidia, even if each conidiogenous cell were to produce only one, or, at most, a few conidia. Gams (1973) discussed a number of fungi, including *Aphanocladium* W. Gams and *Sibirina* Arnold, whose conidiogenous cells strongly resemble phialides but produce only solitary conidia. Recognizing that in many phialidic anamorph genera the first formed conidium originates holoblastically while subsequent ones are enteroblastic, it was suggested that those with solitary conidia might have the sequence interrupted after the first conidium because the conidiiferous opening is too narrow and becomes blocked. It seems possible that *A. typhinum*, at least when grown in pure culture, belongs in this category. The conidiogenous cells produced on host grasses may, however, function as normal phialides or conidia are perhaps abstricted retrogressively in the manner of *Cladobotryum varium* Nees [teleomorph *Hypomyces aurantius* (Pers.) Tul.] as described by Cole and Kendrick (1971). As has been indicated previously (White and Morgan-Jones, 1987) questions relating to conidiogenesis can only be satisfactorily answered following examination of thin sections of conidiogenous cells by transmission electron microscopy.

Following conidiation, the stroma becomes perithecial, but not before cross-fertilization occurs (White and Bultman, 1987). *Epichloe typhina* is now known to be heterothallic since each stroma is self-incompatible. Insect transfer of conidia, which may function as spermatia, from one compatible stroma to another is a prerequisite for further development. Nuclear transfer from a conidium or from a hypha resulting from its germination to a receptive hypha and subsequent dikaryotization of the original conidial ectostroma by migration and replication of the introduced nucleus occurs before perithecia are initiated. The exposed sterile hyphal tips can, possibly, act as trichogynes or conidia and hyphae derived from them may fuse with the interweaving, loosely arranged hyphae in the outer region of the stroma, including those that bore conidiogenous cells. A dikaryotized stroma becomes progressively thicker and more compact, pseudoparenchymatous in texture, and eventually assumes a pale orange coloration. Further growth of hyphae located immediately below the exposed periphery of the stroma, following conidiation, is probably involved in this process.

Conidia, although found to be capable of germination, are not known to play a role in inducing host infection in nature. Sampson (1933) demonstrated that, in *Festuca rubra*, the fungus is transmitted as mycelium in seed. Plants of this grass bearing the fungus systemically were found to frequently show no overt symptoms of infection or loss of vitality, a situation similar to that known to exist in tall fescue [*Festuca arundinacea* Schreber] colonized by *Acremonium coenophialum*. Western and Cavett (1959) were able to experimentally induce infection of *Dactylis glomerata* by application of conidia and ascospores to cut ends of stubble. It is possible that such a route of infection occurs in pastures,

496

26 for E.
19 for *A. typhinum*

read
read

Elymus
Acremonium typhinum

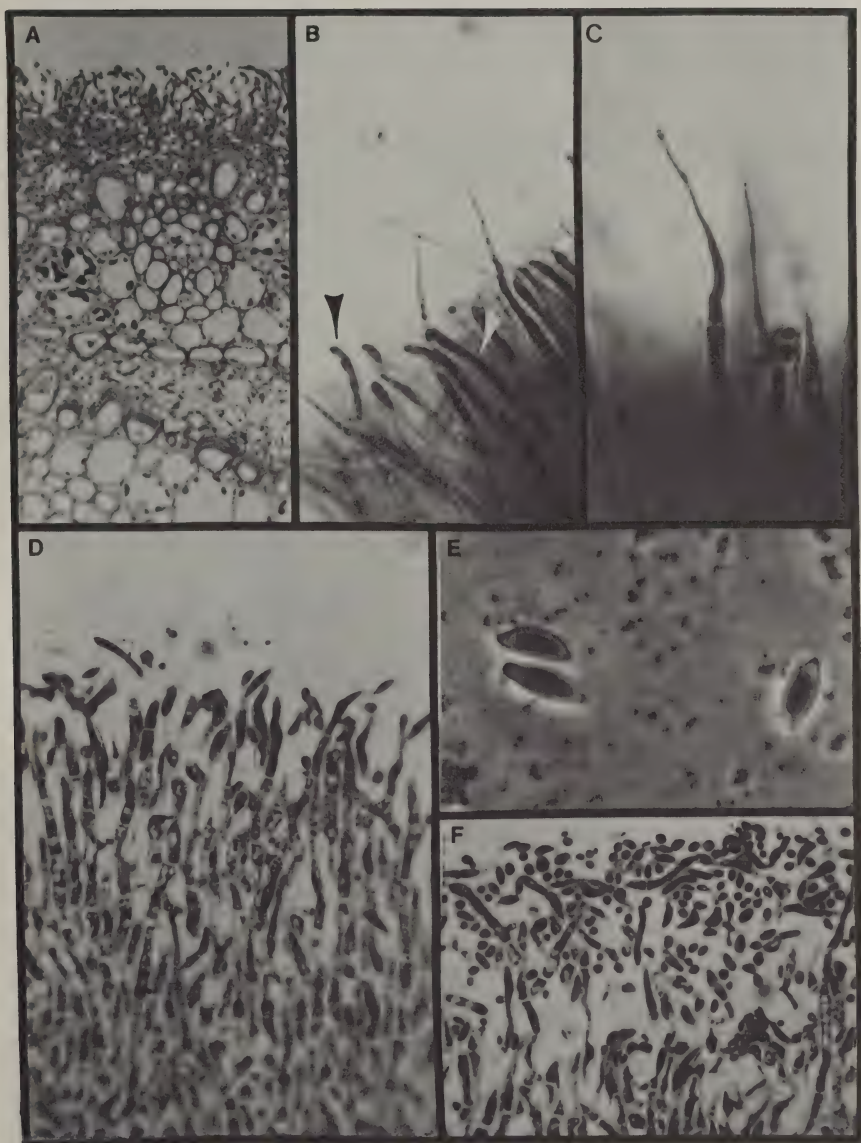


PLATE 2. *Acremonium typhinum* in vivo. A, section of young conidial stroma and host tissue [X 400]; B-C, conidiogenous cells and sterile hyphae (indicated by arrowheads) [B X 1100, C X 1800]; D, mature conidial stroma in section; E, conidia [X 2500]; F, initiation of perithecial stroma by hyphae overgrowing conidial stroma and conidiogenous cell palisade [X 1000].

since Bradshaw (1959) showed incidence of *E. typhina* to be greatest in those heavily grazed. Although natural infection of grasses probably occurs via wind transmitted ascospores, the way in which these induce infection has never been convincingly demonstrated.

The subject of an appropriate classification for endophytic anamorphs currently accommodated in *Acremonium* sect. *Albo-lanosa* remains open to debate. When this section was established (Morgan-Jones and Gams, 1982), no claims of any natural affinity with species classified in other sections of the genus were made. On the contrary, it is well recognized that the form genus *Acremonium* is, in terms of phylogeny, a heterogeneous entity, based primarily on a similar morphology among its members. *Acremonium* anamorphs are known for over twenty species of *Nectria* Fr. (Gams, 1971; Samuels, 1973, 1976a, 1976b) and are included in section *Nectrioidea* W. Gams. The conidiogenous cells of these are considered to be phialides, their tips usually having localized wall thickening and often visible collarettes. In section *Acremonium* [originally named section *Simplex* W. Gams (Gams, 1971)], the conidiogenous cells are also thought to be phialides but wall thickening at their apex is not evident. Section *Gliomastix* (Güeguen) W. Gams [*Gliomastix* Güeguen], which is still maintained as a separate genus by some authors [for example, by Ellis (1976)], accommodates species whose phialides are darkly pigmented. Section *Chaetomioides* Morgan-Jones and W. Gams, typified by *Acremonium alabamensis* Morgan-Jones and W. Gams [teleomorph *Thielavia terrestris* (Apinis) Malloch & Cain] includes anamorphs of the Chaetomiaceae and synanamorphs of *Botryotrichum* Sacc. & March., *Humicola* Traaen, and *Trichocladium* Harz. Given this phylogenetic diversity, a common morphology, and the fact that *Nectria*, another member of the Hypocreales, has *Acremonium* anamorphs, it seems reasonable to argue that the endophytes of grasses placed in section *Albo-lanosa* are as well classified here as anywhere. Admittedly, this is a highly artificial taxonomy, dictated in part by the simplicity of the anamorphs, but short of establishing a separate generic name for the endophytes a more satisfactory solution is not immediately available. The name *Acremonium typhinum*, originally established for the cultural expression of the anamorph of *E. typhina*, has utility in reference to the other similar endophytes, *Acremonium chisosum* White and Morgan-Jones, *A. coenophialum*, *A. huerfanum* White, Cole & Morgan-Jones, and *A. lolii* [as *A. loliae*] Latch, Christensen & Samuels, not known to form conidia *in vivo* or to possess extant teleomorphs.

Substantial differences exist between *Sphacelia segetum* [teleomorph *Claviceps purpurea*] and the anamorph of *E. typhina*. The former has short, doliiiform to flask-shaped, phialidic conidiogenous cells. These are densely packed over the stromal surface which becomes involuted into labyrinthine chambers (Luttrell, 1980). The phialides produce a succession of oblong conidia at their tips and these eventually fill the stromal chambers and eventually ooze out in drops of honeydew. We do not believe that *Sphacelia segetum* and the *Acremonium* anamorph of *E. typhina* can be considered to be congeneric on the basis of their morphology, let alone the fact that they are parts of the life cycles of two different ascomycete genera.

ACKNOWLEDGMENT

We thank Dr. J. Leland Crane, State Natural History Survey Division, Illinois, for reviewing the manuscript.

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NEW TAXA AND COMBINATIONS IN THE LOCULOASCOMYCETES

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During preparation of the manuscript "Prodromus to Class Loculoascomycetes" several new taxa or validations of taxa and recombinations of species became necessary. They are enumerated in the following pages, in a sequence following that used in the major study, where additional details and illustrations are supplied.

Myriangiales:

Seuratiaceae Vuillemin ex Barr, fam. nov.

Seuratiacées Vuillemin, Bull. Soc. Mycol. France 21: 79. 1905, nom. inval., ICBN, Art. 18.

Familia Myriangialium; ascomata irregularia, in sectione irregularibus vel stratis, cellula pallida in matrice gelatinoso composita, asci globosi vel subglobosi dispersi, ascosporae hyalinae vel brunneolae uniseptatae. Genus typicus: *Seuratia* Pat.

Arthoniales:

Johansonia cupulata (Ellis & G. Martin) Barr, comb. nov.

Basionym: *Venturia cupulata* Ellis & G. Martin, Amer. Naturalist 18: 69. 1884.

Capnodiales:

Antennulariella alpina (W. B. Cooke) Barr, comb. nov.

Basionym: *Dimerium alpinum* W. B. Cooke, Mycologia 41: 609. 1949.

Rasutoria Barr, gen. nov.

Genus Euantennariacium; ascomata minuta vel pusilla globosa vel sphaeroidea superficialia appendiculata, subiculum hypharum cylindricarum incrustatarum compositus, asci bitunicati fasciculati saccati vel oblongi apapophysati, ascosporae hyalinae vel brunnescens obovoidae uniseptatae.

Species typica: *Rasutoria abietis* (Dearness) Barr, comb. nov.

Basionym: *Dimerosporium abietis* Dearness, Mycologia 18: 243. 1926. Named in honor of R. A. Shoemaker (*sutor* = shoemaker), for his elucidation of these as well as many other fungi.

Rasutoria tsugae (Dearness) Barr, comb. nov.

Basionym: *Dimerosporium tsugae* Dearness, Mycologia 16: 153. 1924.

Rasutoria pseudotsugae (V. M. Miller & Bonar) Barr, comb. nov.

Basionym: *Dimeriella pseudotsugae* V. M. Miller & Bonar, Univ. California Publ. Bot. 19: 405. 1941.

Rasutoria terrieri (Petrak) Barr, comb. nov.

Basionym: *Dimeriella terrieri* Petrak in Terrier, Bull. Soc. Bot. Suisse 57: 167. 1947.

Dothideales:

Kriegeriellaceae Barr, fam. nov.

Familia Dothidealium; ascomata superficialia conoidea minuta vel pusilla, cellulae peridio radientes superficiales, asci bitunicati fasciculati saccati vel oblongi, ascosporae hyalinae vel brunnescentes obovoideae vel ellipsoideae septatae. Genus typicus: *Kriegeriella* v. Hühnel

Extrawettsteinina andromedae (Auerswald) Barr, comb. nov.

Basionym: *Sphaerella andromedae* Auerswald, Mycol. Europ. Heft V-VI: 12. 1869.

Chaetothyriales Batista & Ciferri ex Barr, ordo nov.

Chaetothyriales Batista & Ciferri, Sydowia Beih. 3: 4. 1962, nom. inval., ICBN, Art. 36.

Ascomata superficialia vel raro subcuticularia globosa sphaeroidea ovoidea vel lenticularia appendiculata vel setosa vel glabra, in subiculo pallide vel fuscato brunneo, periphysoides praesens in centro supero, asci bitunicati saccati vel oblongi, ascosporae hyalinae luteae roseae vel brunnescentes oblongi fusoideae obovoideae vel elongatae septatae. Familia typica: Chaetothyriaceae Hansford ex Barr.

Coccodinium corticola (Ellis & Everh.) Barr, comb. nov.

Basionym: *Pleosphaeria corticola* Ellis & Everh. Proc. Acad. Nat. Sci. Philadelphia 46: 332. 1894.

Berlesiella episphaeria (Peck) Barr, comb. nov.

Basionym: *Dothidea episphaeria* Peck, Ann. Rep. New York State Mus. 30: 64. (for 1876) 1873.

Sthughesia Barr, gen. nov.

Genus Metacapnodiaceum; ascomata perexigua globosa appendiculata, subiculum hypharum moniliformium compositus, centrum periphysoides, asci bitunicati oblongi saccati fasciculati, ascosporae brunneae obovoideae uniseptae verruculosae. Species typica: *Sthughesia juniperi* (Dearness) Barr, comb. nov.

Basionym: *Dimerium juniperi* Dearness, Mycologia 18: 244. 1926. Named in honor of Stanley J. Hughes, for his clarification of the confusing sooty moulds.

Pleosporales:

Dothidotthia andersonii (Shoemaker) Barr, comb. nov.

Basionym: *Gibbera andersonii* Shoemaker, Canad. J. Bot. 41: 1421. 1963.

Dothidotthia ramulicola (Peck) Barr, comb. nov.

Basionym: *Sphaeria ramulicola* Peck, Ann. Rep. New York State Mus. 25: 104. 1873.

Leptosphaeriaceae Barr, fam. nov.

Familia Pleosporalium; ascomata immersi erumpenti vel superficiali, saprobici hemibiotrophici conoidea vel obpyriformia vel sphaeroidea, peridium scleroplectenchymaticum vel pseudoparenchymaticum, asci bitunicati, ascosporae hyalinae vel flavidae brunneolae vel olivaceae brunneae vel vinaceobrunneae ellipsoideae vel fusoidae vel obovoideae vel elongatae septatae. Genus typicus: *Leptosphaeria* Ces. & de Not.

Didymolepta mimuli (Wehmeyer) Barr, comb. nov.

Basionym: *Apiosporella mimuli* Wehmeyer, Mycologia 38: 150. 1946.

Cucurbitaria moriformis (Fuckel) Barr, comb. nov.

Basionym: *Crotonocarpia moriformis* Fuckel, Jahrb. Nassauischen Vereins Naturk. 23-24: 163. 1870.

Parodiellaceae Theissen & H. Sydow ex Barr, fam. nov.

Parodiellaceae Theissen & H. Sydow, Ann. Mycol. 16: 10, 33. 1918, nom. inval., ICBN, Art. 32.

Familia Pleosporalium; ascomata parasitica superficialia perexigua vel mediocria globosa vel ovoidea vel obovoidea vix papillata, asci bitunicati basali oblongi vel late cylindrici, ascosporae hyalinae vel brunneae oblongae vel fusoidae uniseptatae. Genus typicus: *Parodiella* Speg.

Preussia sorghophila (Peck) Barr, comb. nov.

Basionym: *Sphaeria sorghophila* Peck, Ann. Rep. New York State Mus. 31: 51. (for 1877) 1879.

Immotthia Barr, gen. nov.

Genus Dacampiadium; ascomata obpyriformia vel globosa gregaria, asci bitunicati basali oblongi, ascosporae hyalinae vel brunneae fusioideae uniseptatae. Species typica: *Immotthia hypoxylon* (Ellis & Everh.) Barr, comb. nov.

Basionym: *Amphisphaeria hypoxylon* Ellis & Everh. J. Mycol. 2: 41. 1886. The name based on "not at all" *Otthia* from the type species having been arranged in *Otthia* since 1892.

Lasiosterma fimbriatum (Dearness & House) Barr, comb. nov.

Basionym: *Venturia fimbriata* Dearness & House, Bull. New York State Mus. 233-234: 43. 1921.

Eudimeriolum plantaginis (Tehon & Daniels) Barr, comb. nov.

Basionym: *Stigmatea plantaginis* Tehon & Daniels, Mycologia 19: 111. 1927.

Chaetoplea oblongispora (Ellis & Everh.) Barr, comb. nov.

Basionym: *Teichospora oblongispora* Ellis & Everh. Bull. Torrey Bot. Club 25: 503. 1893.

Graphyllum hysterioides (Ellis & Everh.) Barr, comb. nov.

Basionym: *Pleospora hysterioides* Ellis & Everh. Erythea 2: 19. 1894.

Graphyllum ipomoeae (Clements) Barr, comb. nov.

Basionym: *Comoclathris ipomoeae* Clements, Minnesota Bot. Stud. 4: 186. 1911.

Graphyllum planispora (Ellis) Barr, comb. nov.

Basionym: *Pleospora planispora* Ellis, Bull. Torrey Bot. Club 10: 53. 1883.

Kalmusia clivensis (Berkeley & Broome) Barr, comb. nov.

Basionym: *Sphaeria clivensis* Berkeley & Broome, Ann. & Mag. Nat. Hist. Ser. 2, 9: 379. 1852.

Chaetothyria asterinoides (Ellis & G. Martin) Barr, comb. nov. Basionym: *Venturia asterinoides* Ellis & G. Martin, North Amer. Pyrenomyc. 138. 1892.

Melanommatales:

Strickeria kelseyi (Ellis & Everh.) Barr, comb. nov.

Basionym: *Cucurbitaria kelseyi* Ellis & Everh. Proc. Acad. Nat. Sci. Philadelphia 42: 240. 1890.

Karstenula rousseliana (Sacc. & Speg.) Barr, comb. nov.

Basionym: *Thyridium rousselianum* Sacc. & Speg. Michelia 1: 49. 1877.

Neotestudina diplodioides Barr, sp. nov.

Ascomata cleistothecia globosa 0.5-1 mm diametro, peridium tenue cephalothecoideum, asci bitunicati 33-40 x 9-12 μ m quatuor vel octospori, pseudoparaphyses paucae, ascosporae 10-12 x 6-7 μ m, brunneae ellipsoideae uniseptatae, exosporae brunneae, duo pori germinales terminales. Holotypus in ramis *Artemisiae* "near Lynndl, Utah, 1 Jun 1955" leg. K. H. McKnight (MASS).

This species is named for its resemblance to a coelomycete in its production of great numbers of brown, small, one-septate ascospores. *Neotestudina diplodioides* differs in minor morphological details from both *N. rosatii* Segretain & Destombes and *N. cunninghamiae* (Hawksworth & Booth) von Arx & Müller but differs considerably from these two species in substrate and geographical situation. When one associates cleistothecioid taxa with their perithecioid counterparts the genus fits well within the Didymosphaeriaceae.

Acrocordiaceae Oxner ex Barr, fam. nov.

Acrocordiaceae Oxner, Flora Lyšajnykio Ukrainy 144. 1956, nom. inval., ICBN, Art. 36.

Familia Melanommatalium; ascomata immersi erumpenti vel superficiali, in thallo endophloeodes sphaeroidea, peridium pseudoparenchymaticum, asci bitunicati, pseudoparaphyses trabeculae, ascosporae hyalinae vel brunneolae, ellipsoideae vel obovoideae septatae. Genus typicus: *Acrocordia* Massal.

Ostreola formosa (Cooke) Barr, comb. nov.

Basionym: *Hysterium formosum* Cooke, Grevillea 7: 3. 1878.

I thank Dr. C. T. Rogerson for reviewing the manuscript.

NOTICE:

MANAGING EDITOR'S ABSENCE FROM THE ITHACA OFFICE, JULY-SEPTEMBER, 1987

Authors should take note that the Managing Editor, Richard P. Korf, will be in Europe during all of July, August, and September, 1987, attending the International Botanical Congress in Berlin in July, and travelling during most of the rest of this period, so that it will be virtually impossible to contact him easily. All of the editorial duties that he would normally perform will be undertaken by the Associate Editor, Susan C. Gruff. If there are some matters that must necessarily be put off until the Managing Editor's return from Europe, it is hoped that our prospective authors will be understanding. Papers will be accepted for publication by Ms. Gruff during Mr. Korf's absence, and subsequent orders for offprints will also be accepted, but these orders will not be officially processed nor invoiced until after Mr. Korf's return in October. Authors should not feel concerned about offprint orders for accepted articles, as their orders will be attended to shortly after October 1st. .

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Page 280 line 33 *for* Hiroshima *read* Yamaguchi

ERRATA, VOLUME TWENTY-SEVEN

Page 67 line 17 *for* (% , v/v) *read* (% , w/v)

ERRATA, VOLUME TWENTY-EIGHT

Page 563 Index *for* Heterosphaeria patella a alpestris
read Heterosphaeria patella α alpestris
 565 Index *for* Ophiostoma *adjuncti* 411; *read* Ophiostoma *adjuncti* 41;
for Parmelia stygia b sorediata *read* Parmelia stygia β sorediata
for Phacidium patella a alpestris 266; b campestre
read Phacidium patella α alpestris 266; β campestre
 566 Index *for* Sphaeria penetrans a patella *read* Sphaeria penetrans β patella
 567 Index *for* Tympanus patella a sphaeriaeformis 273; b pezizaeformis 266
read Tympanis patella α sphaeriaeformis 273; β pezizaeformis 266

ERRATA, VOLUME TWENTY-NINE

Page 102 line 13 *for* **L. dryinum** *read* **Leptothyrium dryinum**
 19 *for* **A. dryina** *read* **Actinopelte dryina**
 441 26 *for* chrysophthalma" *read* chrysophthalma"
 58 *for* aciculum *read* acicola
 442 14 *for* carpinicolus *read* carpinicola
 443 47 *for* "L. intumes- *read* "Lecidea intumes-
 444 55 *for* personii *read* persoonii
 445 8 *for* nootkatenis (terrier) *read* nootkatensis (Terrier)
 492 23 *for* *E. canadensis* *read* *Elymus canadensis*
 24 *for* *A. hiemalis* *read* *Agrostis hiemalis*
 494 24 *for* *E. typhina* *read* *Epichloe typhina*
 26 *for* *E.* *read* *Elymus*
 496 19 *for* *A. typhinum* *read* *Acremonium typhinum*

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